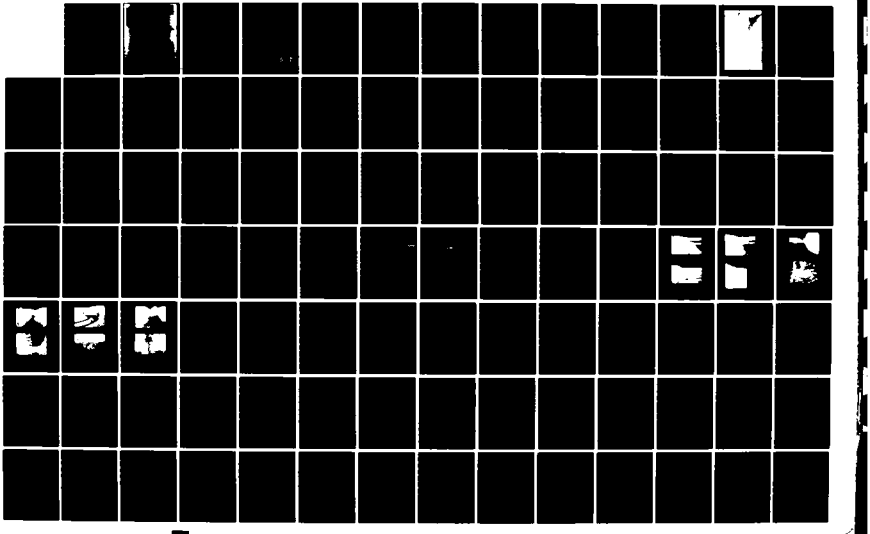
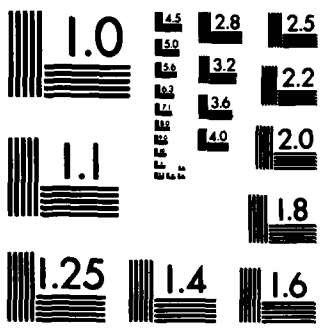
AD-A143 938 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS BRISTOL RESERVOIR NUM.. (U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV JUN 81 1/2

UNCLASSIFIED F/G 13/13 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

FARMINGTON RIVER BASIN
HARWINTON, CONNECTICUT

BRISTOL RESERVOIR NO. 2 DAM
CT 00365

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROG

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: CT 00365	2. GOVT ACCESSION NO.: AD-A143938
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE (and Subtitle): Bristol Reservoir No.2 Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS	5. TYPE OF REPORT & PERIOD COVERED: INSPECTION REPORT
	6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION	8. CONTRACT OR GRANT NUMBER(s):
9. PERFORMING ORGANIZATION NAME AND ADDRESS:	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
11. CONTROLLING OFFICE NAME AND ADDRESS: DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254	12. REPORT DATE: June 1981 13. NUMBER OF PAGES: 60
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office):	15. SECURITY CLASS. (of this report): UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Farmington River Basin
Harwinton, Connecticut

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Bristol Reservoir No.2 is a storage reservoir for public water supply. The dam consists of an earth embankment with a top width of 10 feet, a maximum height of 33 feet and a total length of 650 feet including a 20 foot overflow spillway located near the left end of the dam. Based on the visual inspection, the dam is judged to be in good condition. The dam is classified as "Small" in size with a "Significant" hazard potential. A test flood equal to ½ the Probable Maximum Flood was selected.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

BRISTOL RESERVOIR NO. 2 DAM
CT 00365

FARMINGTON RIVER BASIN
HARWINTON, CONNECTICUT

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

49-044

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

IDENTIFICATION NO: CT 00365

NAME OF DAM: Bristol Reservoir No. 2 Dam

TOWN: Harwinton

COUNTY AND STATE: Litchfield County, Connecticut

STREAM: Tributary to Poland River

DATE OF INSPECTION: April 28, 1981

BRIEF ASSESSMENT

Bristol Reservoir No. 2 is a storage reservoir for public water supply owned by the Bristol Water Department. The dam consists of an earth embankment with a top width of 10 feet, a maximum height of 33 feet and a total length of 650 feet including a 20 foot overflow spillway located near the left end of the dam. The outlet works located near the center of the dam consist of a 12-inch cast iron low level outlet or blowoff through the dam controlled by a downstream gate.

Based on the visual inspection, the dam is judged to be in good condition. Features that could affect the future integrity of the dam are downstream seepage, trees growing adjacent to the downstream toe, the downstream location of the low level outlet or blowoff control valve, and brush in the downstream spillway channel.

The dam is classified as "Small" in size with a "Significant" hazard potential. A Test Flood equal to one-half the Probable Maximum Flood (1/2 PMF) was selected in accordance with the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams.

The Test Flood inflow of 330 cfs results in a routed outflow of 225 cfs and a freeboard of 1.2 feet.

The spillway capacity with the 9-inch high flashboards in place is 430 cfs or 191 percent of the Test Flood routed outflow.

It is recommended that the owner retain the services of a qualified, registered engineer to investigate the downstream seepage, and to design an upstream gate for the low level outlet or blowoff. In addition, trees and stumps should be removed from downstream of the dam, the brush in the spillway channel should be cut, a program of technical inspections should be instituted, an Operation and Maintenance Manual should be prepared, and a downstream warning system should be developed.

The owner should implement these recommendations as described herein and in greater detail in Section 7 of this Report within two years of receipt of this Phase I Inspection Report.

Ronald G. Litke, P.E.
Project Engineer

Roald Haestad
President

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the

condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

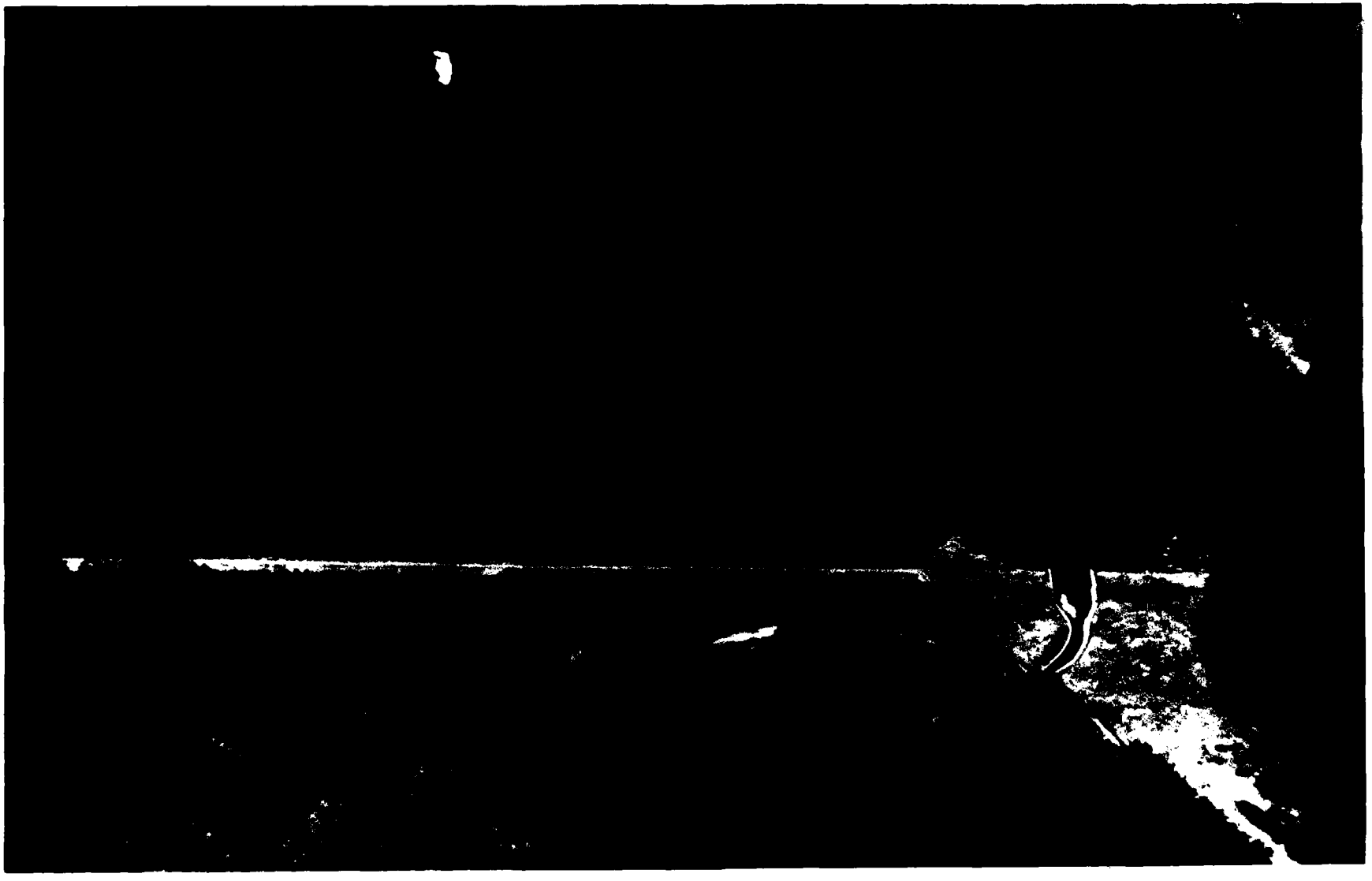
Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety of the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

TABLE OF CONTENTS

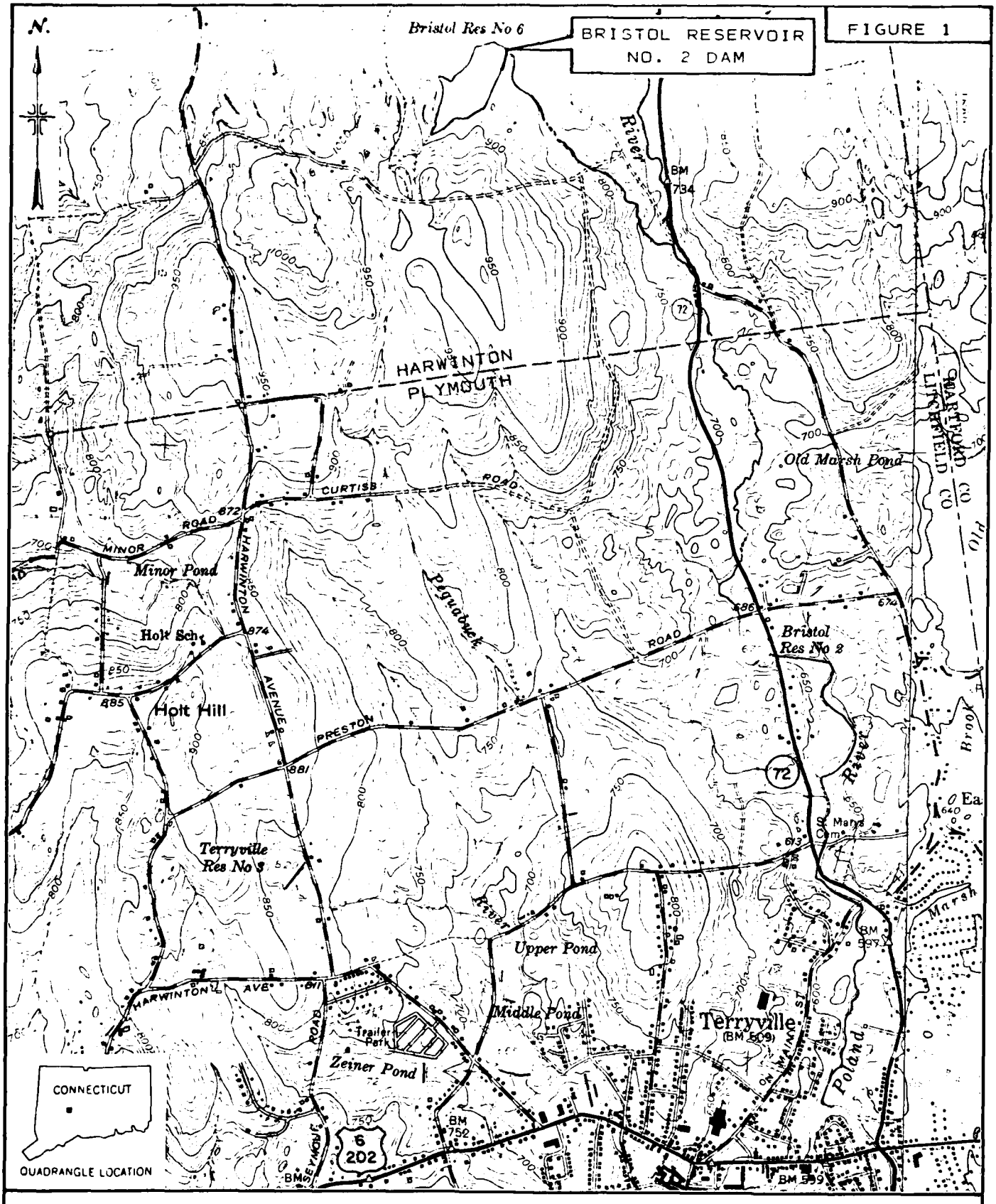
INDEX TO REPORT

INDEX TO APPENDIXES



OVERVIEW PHOTO

U.S.ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BRISTOL RES. NO. 2 DAM - CT 00365
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		TRIBUTARY TO POLAND RIVER
		HARWINTON, CONNECTICUT — 7 APRIL '81



LOCATION PLAN

BRISTOL RESERVOIR NO. 2 DAM
HARWINTON, CONNECTICUT

SCALE: 1" = 2000'

ROALD HAESTAD, INC. THOMASTON QUADRANGLE 1969

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

BRISTOL RESERVOIR NO. 2 DAM

PROJECT INFORMATION

SECTION 1

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Roald Haestad, Inc., has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Roald Haestad, Inc. under a letter of March 30, 1981, from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0048 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection

The purposes of the program are to:

1. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interest.
2. Encourage and prepare the States to quickly initiate effective dam inspection programs for non-federal dams.
3. To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location

The dam is located on an unnamed tributary to the Poland River, approximately 2,500 feet west of Connecticut Route 72 in the southeast section of Harwinton, Connecticut. The dam is shown on the Thomaston Quadrangle Map having coordinates of latitude N41°-43.5' and longitude W73°-01.4'. The impoundment is incorrectly labled Bristol Reservoir No. 6 on the Thomaston Quadrangle Map.

b. Description of Dam and Appurtenances

The dam consists of an earth embankment with a maximum height of 33 feet and a total length of 650 feet, including a 20 foot overflow spillway located near the left end of the dam. The dam has a top width of 10 feet, an upstream slope of 2 horizontal to 1 vertical, and a downstream slope of 1.6 horizontal to 1 vertical. The upstream slope is protected by riprap slope protection, and the downstream slope and crest are grass-covered.

The overflow spillway consists of a 20 foot long broad-crested concrete weir between concrete training walls. The top of the dam is about 4.25 feet above the spillway crest and about 3.5 feet above the 9-inch high flashboards which are normally in place. The spillway discharges into a narrow, concrete-lined rectangular channel, which flows under a concrete bridge about 75 feet downstream of the spillway.

The outlet works located near the center of the dam consist of a 12-inch cast iron low level outlet or blowoff pipe through the dam with two manually operated downstream gate valves. The

first valve is reported to be inoperable and remains open, while the downstream valve is used to regulate the flow.

c. Size Classification - "Small"

According to the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, a dam is classified as "Small" in size if the height is between 25 feet and 40 feet or the dam impounds between 50 Acre-Feet and 1,000 Acre-Feet. The dam has a maximum height of 33 feet and a maximum storage capacity of 400 Acre-Feet. Therefore the dam is classified as "Small" in size.

d. Hazard Classification - "Significant"

Based on the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, the hazard classification of the dam is "Significant". A dam failure analysis indicates that Connecticut Route 72 located about 4,000 feet downstream of the dam would be overtopped by approximately 5 feet as a result of the dam failure. After flowing through a large swampy area the flood waters would overtop Connecticut Route 72, Preston Road, the dam at Bristol Reservoir No. 3 (incorrectly labeled as Bristol Reservoir No. 2 on the U.S.G.S. Quadrangle Sheet) and Connecticut Route 72 for a third time before being contained within the flood plain. The maximum spillway flow prior to dam breach would be contained within the river banks. The failure of Bristol Reservoir No. 2 Dam could cause the overtopping of a downstream water supply reservoir and a secondary State highway, possibly resulting in the loss of a few lives.

e. Ownership

Bristol Water Department
119 Riverside Street
Bristol, Connecticut 06010
John Burns, Superintendent
(203) 582-7431

f. Operator

Leonard Valentino
Bristol Filter Plant
Off of Clark Avenue
Bristol, Connecticut 06010
(203) 583-6504

g. Purpose of Dam

The dam impounds Bristol Reservoir No. 2, a storage reservoir for public water supply for the Bristol Water Department.

h. Design and Construction History

The dam was constructed in 1889, and is shown on a plan entitled "Map of Reservoir No. 2, Bristol Water Company, October, 1890, R.D. Barnes, C.E." (see Appendix B, page B-3). Approximately 20 years ago the spillway was rebuilt by the owner's forces. About 8 years ago the spillway weir and channel were gunited by Penetryn System, Inc. Around this time the Water Department also installed a drain along the downstream toe and a new gate on the low level outlet or blowoff.

i. Normal Operational Procedures

Water is drawn from the reservoir through the low level outlet or blowoff as required to supply water to a downstream distribution reservoir.

1.3 Pertinent Data

a. Drainage Area

The drainage area consists of 0.31 square miles of "rolling" wooded hills. The entire drainage area is undeveloped and owned by the Bristol Water Department.

b. Discharge at Damsite

Discharge at the damsite is over a 20 foot overflow spillway. A 12-inch low level outlet or blowoff is opened as required to supply water to a downstream distribution reservoir.

1.	Outlet Works (conduits) Size:	12-inch
	Invert Elevation:	847.5
	Discharge Capacity:	13 cfs
2.	Maximum Known Flood at Damsite:	Unknown
3.	Ungated Spillway Capacity at Top of Dam:	430 cfs *
	Elevation:	880.5
4.	Ungated Spillway Capacity at Test Flood Elevation:	225 cfs *
	Elevation:	879.3
5.	Gated Spillway Capacity at Normal Pool Elevation:	N/A
	Elevation:	N/A
6.	Gated Spillway Capacity at Test Flood Elevation:	N/A
	Elevation:	N/A
7.	Total Spillway Capacity at Test Flood Elevation:	225 cfs *
	Elevation:	879.3
8.	Total Project Discharge at Top of Dam:	430 cfs *
	Elevation:	880.5
9.	Total Project Discharge at Test Flood Elevation:	225 cfs *
	Elevation:	879.3

*with 9-inch flashboards

c. Elevation - Feet Above Mean Sea Level (NGVD)

1.	Streambed at Toe of Dam:	847.5
2.	Bottom of Cutoff:	N/A
3.	Maximum Tailwater:	N/A
4.	Normal Pool:	877 (top of flashboards)
5.	Full Flood Control Pool:	N/A
6.	Spillway Crest:	876.25
7.	Design Surcharge - Original Design:	Unknown
8.	Top of Dam:	880.5
9.	Test Flood Surcharge:	879.3 (with flashboards)

d. Reservoir - Length in Feet

1.	Normal Pool:	1,500
2.	Flood Control Pool:	N/A
3.	Spillway Crest Pool:	1,500
4.	Top of Dam:	1,500
5.	Test Flood Pool:	1,500

e. Storage - Acre-feet

1.	Normal Pool:	325 (top of flashboards)
2.	Flood Control Pool:	N/A
3.	Spillway Crest Pool:	300
4.	Top of Dam:	400
5.	Test Flood Pool:	370

f. Reservoir Surface - Acres

1.	Normal Pool:	19
2.	Flood-Control Pool:	N/A
3.	Spillway Crest:	19
4.	Test Flood Pool:	20
5.	Top of Dam:	21

g. Dam

1.	Type:	Earth Embankment
2.	Length:	650 feet
3.	Height:	33 feet
4.	Top Width:	10 feet
5.	Side Slopes:	Upstream - 2 horizontal to 1 vertical Downstream - 1.6 horizontal to 1 vertical
6.	Zoning:	Unknown
7.	Impervious Core:	Unknown
8.	Cutoff:	Unknown
9.	Grout Curtain:	None
10.	Other:	

h. Diversion and Regulating Tunnel N/A

i. Spillway

1. Type:	Broad-crested concrete overflow
2. Length of Weir:	20 feet
3. Crest Elevation with Flash Boards: without Flash Boards:	 877.0 876.25
4. Gates:	N/A
5. Upstream Channel:	Concrete apron upstream of flashboards.
6. Downstream Channel:	Narrow concrete lined channel from spillway to service bridge. Natural channel below bridge.
7. General:	

j. Regulating Outlets

1. Invert:	847.5
2. Size:	12-inch
3. Description:	Cast iron low level outlet or blowoff pipe through dam.
4. Control Mechanism:	Downstream manually operated gate valve
5. Other:	Original gate inoperative. Pipe extended and new gate installed downstream.

2.1 Design Data

The only information available on the dam consists of a plan entitled "Map of Reservoir No. 2, Bristol Water Department, October 1890, R.D. Barnes, C.E.".

2.2 Construction Data

The dam was originally constructed in 1889 as shown on the above-noted plan. It was reported that the spillway was rebuilt about 20 years ago by the owner's forces. Approximately 8 years ago the spillway weir and channel were gunited by Penetryn System, Inc. Also around this time the Water Department installed a drain along the downstream toe and a new gate on the low level outlet or blowoff line.

2.3 Operation Data

Lake levels are recorded once a month and do not necessarily coincide with maximum water levels. The amount of flow over the spillway during the 1955 Floods is unknown because the dam was inaccessible due to the downstream flooding.

2.4 Evaluation of Data

a. Availability

Existing data was provided by the Bristol Water Department.

b. Adequacy

As there was very little information available, the assessment of the condition of the dam was based mainly on the visual inspection, past performance history, and hydraulic and hydrologic calculations performed for this report.

c. Validity

Field inspections and surveys revealed that the dam is constructed substantially as shown on the existing plan.

VISUAL INSPECTION

SECTION 3

3.1 Findings

a. General

The visual inspection of the dam was conducted on April 28, 1981. At the time of inspection, 9-inch high flashboards were in place and the water level was about 0.1 feet below the top of the boards.

The dam consists of an earth embankment with an overflow spillway located at the left end, and the outlet works located near the center of the dam, Photos 1 and 2. A ledge outcrop approximately 50 feet to the right of the spillway separates the spillway from the remaining part of the dam.

The general condition of the dam at the time of inspection was good.

b. Dam

The upstream slope of the earth embankment is covered with riprap slope protection which extends slightly above the normal waterline. Near the right end of the dam there are several shelves formed by the riprap, Photo 3. In these areas the riprap was placed on ledge outcrops which were visible below the surface of the water.

The crest of the dam is covered with a well-maintained grass cover, Photos 1 and 3. The visual inspection and field survey performed for this report did not indicate any signs of erosion or settlement of the crest.

The downstream slope is covered with a well-maintained grass cover, Photos 2 and 4. Field surveys indicate that the downstream face of the dam has a slope of 1.6 horizontal to 1 vertical. Approximately 150 feet to the right of the spillway there is what appears to be a former animal burrow, Photo 4, as indicated by a depression near the upper part of the slope with a bulge in the slope immediately below. There were no signs of instability in this area of the slope at the time of inspection. Near the right end of the dam there are numerous evergreen trees just beyond the downstream toe, Photo 5.

Approximately 200 feet from the right end of the dam there was a small wet and spongy area at the toe of the downstream slope. There are ledge outcrops immediately upstream and downstream of the dam in this area. A second wet area was present at the downstream toe of the dam approximately 125 feet to the right of the spillway, Photo 6. The area was approximately 30 feet long by about 3 feet wide. There was no noticeable flow from either of these areas.

At the downstream toe of the dam from the discharge end of the outlet works to the ledge outcrop near the spillway there is a gravel road and drain which was reportedly installed about 8 years ago to control seepage, Photo 7. A 4-inch PVC drain pipe discharging approximately 2 - 3 gpm at the time of inspection extends from this area, Photo 8. The area downstream of the gravel road and drain is also wet and contains moisture-loving vegetation, Photo 7.

c. Appurtenant Structures

The appurtenant structures consist of the overflow spillway, the outlet works and a service bridge over the spillway discharge channel.

Spillway

The concrete overflow spillway and training walls appeared to be in good condition, Photo 9. At the time of inspection 9-inch high flashboards were in place. The walls which line the spillway discharge channel were reportedly gunited about 8 years ago. The gunite was cracked considerably and efflorescence was present on the face of these walls, Photo 10. The floor of the discharge channel appeared to consist of a layer of gunite over stone paving. The gunite layer has broken up. The spillway channel downstream of the service bridge is overgrown with brush.

Outlet Works

The outlet works consist of a 12-inch cast iron pipe through the dam with two manually operated gates at the downstream toe of the dam. The gate at the outlet end of the pipe is reported to be operable and was installed about 8 years ago when problems with the original gate arose. The original gate is reportedly left open.

Service Bridge

The concrete service bridge over the spillway discharge channel appears to be in good condition, Photo 10. The bridge provides access to the low level outlet or blowoff gates at the downstream toe of the dam.

d. Reservoir Area

There were no signs of instability along the edges of the reservoir in the vicinity of the dam.

e. Downstream Channel

The spillway channel downstream of the service bridge is overgrown with brush and small trees, Photo 11. No significant obstructions to the flow were observed in the natural channel at the discharge end of the low level outlet or blowoff, Photo 12.

3.2 Evaluation

On the basis of the visual inspection, the dam is judged to be in good condition. The following features could affect the future integrity of the dam:

1. Seepage as indicated by the wet areas at the downstream toe could lead to piping and internal erosion.
2. The trees adjacent to the downstream toe at the right end of the dam could lead to the development of root systems extending through the dam. Seepage could develop along these root systems. The trees could also uproot and cause damage to the embankment.
3. The downstream location of the control gate on the low level outlet or blowoff line permits full water pressure to exist in the outlet pipe through the dam and does not allow for flow to be shut off in the event of a leak in the outlet pipe.
4. The presence of brush in the downstream spillway channel could restrict flow through the channel.

OPERATIONAL AND MAINTENANCE PROCEDURES
SECTION 4

4.1 Operational Data

a. General

Water is drawn from the reservoir through the low level outlet or blowoff as required to supply water to a downstream distribution reservoir.

b. Description of Any Warning System in Effect

There is no formal warning system in effect. The dam is monitored during heavy rains.

4.2 Maintenance Procedures

a. General

Normal maintenance procedures consist of regular mowing and the application of fertilizer and lime to grassed areas of the dam.

b. Operating Facilities

Repairs are made as required.

4.3 Evaluation

Present operations and maintenance procedures are adequate and should remain in effect. An Operations and Maintenance Manual should be prepared for the dam and operating facilities, a formal downstream warning system should be put into effect and technical inspections by a qualified, registered engineer should be made every two years.

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES
SECTION 5

5.1 General

Bristol Reservoir No. 2 is impounded by an earthen embankment along the east side of the reservoir. The reservoir stores about 325 Acre-Feet at the top of 9-inch high flashboards that are normally in place and 400 Acre-Feet at the top of the dam. The spillway is a 20 foot long concrete broad-crested weir with concrete training walls. The spillway is located near the left end of the dam and has 3.5 feet of freeboard from the top of the flashboards to the crest of the dam.

The dam has a tributary watershed of 0.31 square miles of "rolling" wooded hills. The watershed is completely undeveloped and is owned entirely by the Bristol Water Department. The watershed elevation ranges from a maximum of 1060 feet at the north and west to 877 feet at the spillway.

The outlet works consist of a single 12-inch cast iron low level outlet or blowoff pipe through the dam with two downstream gate valves. The first valve is reported to be inoperable and remains open, while the downstream valve is used to regulate the flow. The outlet capacity was calculated to be about 13 cfs.

5.2 Design Data

Available design data consists of a plan of the dam and reservoir dated October 1890 giving the surface area and storage capacity.

5.3 Experience Data

The maximum depth of flow over the spillway is unknown. The dam has reportedly never been overtopped. During the 1955 floods the area was inaccessible because of downstream flooding.

5.4 Test Flood Analysis

Based on the dam failure analysis, the dam is classified as "Significant" hazard potential. The dam is classified as "Small" in size based on a height of 33 feet and a storage capacity of 400 Acre-Feet. According to the Recommended Guidelines for Safety Inspection of Dams, by the Corps of Engineers, the Test Flood should be in the range of the 100-Year Flood to one-half the Probable Maximum Flood (1/2 PMF) depending on the involved risk. A Test Flood equal to the 1/2 PMF was selected because of the height of the embankment. The Test Flood was calculated using a peak inflow for the PMF of 2,125 cubic feet per second per square mile (csm) from the minimum two square mile drainage area shown on the Corps of Engineers' Guide Curves for "rolling" terrain and the 0.31 square mile watershed of Bristol Reservoir No. 2. The peak 1/2 PMF inflow was calculated to be 330 cfs, resulting in a routed outflow of 225 cfs.

The Test Flood was routed through the impoundment in accordance with the Corps of Engineers' procedures for "Estimating the Effect of Surcharge Storage on Probable Maximum Discharges". The impoundment was assumed to be initially at the top of the flashboards. The spillway is capable of discharging 430 cfs with the flashboards in place or 191 percent of the Test Flood routed outflow.

5.5 Dam Failure Analysis

The Corps of Engineers' '"Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs' was used to calculate the peak outflow due to a dam failure. Failure was assumed with the water level at the top of the dam. The 33 foot deep by 50 foot wide breach would release up to 16,000 cfs into the stream channel below the dam. The flood wave would travel in a relatively steep, narrow channel for a distance of about 4,000 feet before overtopping Connecticut Route 72 by about 5 feet. After crossing Route 72 the flood wave would enter a large swampy area and be reduced to about 4,500 cfs. The flood waters would then overtop Route 72 again, as well as Preston Road, the dam at Bristol Reservoir No. 3 (incorrectly labled Bristol Reservoir No. 2 on the U.S.G.S. Quadrangle sheet) and Route 72 for a third time. Beyond that point the flood waters would remain within the flood plain. Prior to dam breach, the spillway discharge would be contained within the stream channel.

The failure of Bristol Reservoir No. 2 Dam could cause the overtopping of a water supply reservoir dam and a State highway, with the possible loss of a few lives. Therefore, the dam is classified as "Significant" hazard potential.

EVALUATION OF STRUCTURAL STABILITY

SECTION 6

6.1 Visual Observations

The visual inspection did not disclose any indications of structural instability. The future integrity of the dam may be affected by continued seepage at the downstream toe and the location of the control valve at the downstream end of the low level outlet or blowoff line.

6.2 Design and Construction Data

There is no detailed information available on the design and construction of the dam.

6.3 Post-Construction Changes

Since the original construction of the dam in 1889, the following changes have been made:

1. The spillway was rebuilt about 20 years ago.
2. The spillway weir and discharge channel were gunited about 8 years ago.
3. A new gate was installed on the low level outlet or blowoff line approximately 8 years ago.

6.4 Seismic Stability

The dam is located in Seismic Zone 1 and in accordance with the recommended Phase I Guidelines, does not warrant seismic stability analysis.

7.1 Dam Assessment

a. Condition

On the basis of the visual inspection, the dam is judged to be in good condition. The future integrity of the dam could be affected by:

1. Downstream seepage;
2. Trees growing adjacent to the downstream toe;
3. The downstream location of the control valve on the low level outlet or blowoff; and
4. The presence of brush in the downstream spillway channel.

An evaluation of the hydraulic and hydrologic features of the dam determined that the spillway is capable of passing 191 percent of the Test Flood routed outflow with the present flashboards in place.

b. Adequacy of Information

As there was very little information available, the assessment of the condition of the dam was based mainly on the visual inspection, past performance history and hydraulic and hydrologic calculations performed for this report.

c. Urgency

The recommendations presented in Section 7.2 and 7.3 should be carried out by the owner within two years of receipt of this report.

7.2 Recommendations

The following recommendations should be carried out under the direction of a qualified, registered engineer:

1. Remove trees and stumps from the area within 20 feet of the downstream toe and backfill with suitable material.
2. Investigate the significance of the seepage at the downstream toe. Design and construct seepage control and/or monitoring measures as needed.
3. Design and construct an upstream gate for the low level outlet or blowoff.

7.3 Remedial Measures

a. Operations and Maintenance Procedures

1. Remove brush from the downstream spillway channel.
2. Establish a program of technical inspections to be made by a qualified, registered engineer every two years.
3. Prepare an Operations and Maintenance Manual for the dam and operating facilities.
4. Develop and put into effect a downstream warning system in the event of an emergency at the dam.

7.4 Alternatives

There are no practical alternatives to the the recommendations contained herein.

APPENDIX A

VISUAL CHECK LIST WITH COMMENTS

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT: BRISTOL RESERVOIR NO. 2 DAM

DATE: 28 April 1981 TIME: 12:00 noon WEATHER: Cloudy 55°F

W.S. ELEVATION: 876.9 U.S. N/A DN.S
0.1' below top of 9" flashboards

	PARTY	DISCIPLINE
1.	Roald Haestad, P.E., Roald Haestad, Inc.	Civil/Geotechnical
2.	Donald L. Smith, P.E., Roald Haestad, Inc.	Civil/Hydrologic
3.	Ronald G. Litke, P.E., Roald Haestad, Inc.	Civil/Structural
4.		
5.		
6.		

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam Embankment	RH, DLS, RGL	Good condition
2.	Outlet Works, Intake Channel and Structure	RH, DLS, RGL	None observed
3.	Outlet Works, Control Tower	RH, DLS, RGL	Downstream gate valves
4.	Outlet Works, Transition and Conduit	RH, DLS, RGL	Cast iron pipe through dam
5.	Outlet Works, Outlet Structure and Channel	RH, DLS, RGL	Structure is stone masonry wall, Channel is natural stream
6.	Outlet Works, Spillway Weir, Approach & Discharge Channel	RH, DLS, RGL	Spillway in good condition, gunite cracked on walls of discharge channel
7.	Outlet Works, Service Bridge	RH, DLS, RGL	Good condition
8.			
9.			
10.			
11.			
12.			

PERIODIC INSPECTION CHECK LIST

PROJECT: BRISTOL RESERVOIR NO. 2 DAM DATE: 28 April 1981

PROJECT FEATURE: DAM EMBANKMENT NAME: RH

DISCIPLINE: CIVIL ENGINEERS NAME: DLS, RGL

AREA ELEVATION	CONDITIONS
DAM EMBANKMENT	
CREST ELEVATION	880.5
CURRENT POOL ELEVATION	876.9
MAXIMUM IMPOUNDMENT TO DATE	Unknown
SURFACE CRACKS	None observed
PAVEMENT CONDITION	No pavement. Crest is covered with grass.
MOVEMENT OR SETTLEMENT OF CREST	None observed
LATERAL MOVEMENT	None observed
VERTICAL ALIGNMENT	Good
HORIZONTAL ALIGNMENT	Good
CONDITION AT ABUTMENT AND AT CONCRETE STRUCTURES	Good
INDICATIONS OF MOVEMENT OF STRUCTURAL ITEMS ON SLOPES	No items present on slopes.
TRESPASSING ON SLOPES	None observed
VEGETATION ON SLOPES	Well maintained grass cover
SLOUGHING OR EROSION OF SLOPES OR ABUTMENTS	Former animal burrow on downstream slope
ROCK SLOPE PROTECTION - RIPRAP FAILURES	Good condition
UNUSUAL MOVEMENT OR CRACKING AT OR NEAR TOES	None observed
EMBANKMENT OR DOWNSTREAM SEEPAGE	Two wet areas at downstream toe. No flow through either area.
PIPING OR BOILS	None observed
FOUNDATION DRAINAGE FEATURES	Downstream gravel drain 2-3 gpm discharging from 4" PVC pipe.
TOE DRAINS	Downstream gravel drain 2-3 gpm discharging from 4" PVC pipe
INSTRUMENTATION SYSTEM	None known

PERIODIC INSPECTION CHECK LIST

PROJECT: BRISTOL RESERVOIR NO. 2 DAM DATE: 28 April 1981

PROJECT FEATURE: OUTLET WORKS: INTAKE CHANNEL INTAKE STRUCTURE NAME: RH

DISCIPLINE: CIVIL ENGINEERS NAME: DLS, RGL

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	No intake structure or channel observed
A. APPROACH CHANNEL:	
SLOPE CONDITIONS	
BOTTOM CONDITIONS	
ROCK SLIDES OR FALLS	
LOG BOOM	
DEBRIS	
CONDITION OF CONCRETE LINING	
DRAINS OR WEEP HOLES	
B. INTAKE STRUCTURE:	
CONDITION OF CONCRETE	
STOP LOGS AND SLOTS	

PERIODIC INSPECTION CHECK LIST

PROJECT: BRISTOL RESERVOIR NO. 2 DAM DATE: 28 April 1981

PROJECT FEATURE: OUTLET WORKS - CONTROL TOWER NAME: RH

DISCIPLINE: CIVIL ENGINEERS NAME: DLS, RGL

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER	No control tower. Outlet works controlled by 2 manually operated downstream gate valves.
A. CONCRETE AND STRUCTURAL:	
GENERAL CONDITION	
CONDITION OF JOINTS	
SPALLING	
VISIBLE REINFORCING	
RUSTING OR STAINING OF CONCRETE	
ANY SEEPAGE OR EFFLORESCENCE	
JOINT ALIGNMENT	
UNUSUAL SEEPAGE OR LEAKS IN GATE CHAMBER	
CRACKS	
RUSTING OR CORROSION OF STEEL	
B. MECHANICAL AND ELECTRICAL:	
AIR VENTS	
FLOAT WELLS	
CRANE HOIST	
ELEVATOR	
HYDRAULIC SYSTEM	
SERVICE GATES	First gate reported inoperable, downstream gate reported to be operable.
EMERGENCY GATES	
LIGHTNING PROTECTION SYSTEM	
EMERGENCY POWER SYSTEM	
WIRING AND LIGHTING SYSTEM IN GATE CHAMBER	

PERIODIC INSPECTION CHECK LIST

PROJECT: BRISTOL RESERVOIR NO. 2 DAM DATE: 28 April 1981

PROJECT FEATURE: OUTLET WORKS - TRANSITION AND CONDUIT NAME: RH

DISCIPLINE: CIVIL ENGINEERS NAME: RGL, DLS

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	Conduit consists of 12-inch cast iron pipe through embankment
GENERAL CONDITION OF CONCRETE	
RUST OR STAINING ON CONCRETE	
SPALLING	
EROSION OR CAVITATION	
CRACKING	
ALIGNMENT OF MONOLITHS	
ALIGNMENT OF JOINTS	
NUMBERING OF MONOLITHS	

PERIODIC INSPECTION CHECK LIST

PROJECT: BRISTOL RESERVOIR NO. 2 DAM DATE: 28 April 1981

PROJECT FEATURE: OUTLET WORKS: OUTLET STRUCTURE OUTLET CHANNEL NAME: RH

DISCIPLINE: CIVIL ENGINEERS NAME: DLS, RGL

AREA EVALUATED	CONDITIONS
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
GENERAL CONDITION OF CONCRETE	Stone masonry end wall
RUST OR STAINING	N/A
SPALLING	N/A
EROSION OR CAVITATION	None observed
VISIBLE REINFORCING	N/A
ANY SEEPAGE OR EFFLORESCENCE	None observed
CONDITION AT JOINTS	N/A
DRAIN HOLES	Open joints in stone masonry
CHANNEL	Natural stream
LOOSE ROCK OR TREES OVERHANGING CHANNEL	Some small trees overhanging channel; No obstruction to flow
CONDITION OF DISCHARGE CHANNEL	Good

PERIODIC INSPECTION CHECK LIST

PROJECT: BRISTOL RESERVOIR NO. 2 DAM DATE: 28 April 1981

PROJECT FEATURE: OUTLET WORKS: SPILLWAY WEIR, APPROACH & DISCHARGE CHANNEL NAME: RH

DISCIPLINE: CIVIL ENGINEERS NAME: DLS, RGL

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
A. APPROACH CHANNEL:	
GENERAL CONDITION	Good
LOOSE ROCK OVERHANGING CHANNEL	None
TREES OVERHANGING CHANNEL	None
FLOOR OF APPROACH CHANNEL	Concrete apron upstream of flashboards
B. WEIR AND TRAINING WALLS:	
GENERAL CONDITION OF CONCRETE	Good; cracking of gunite on downstream channel walls
RUST OR STAINING	None observed
SPALLING	None observed
ANY VISIBLE REINFORCING	None observed
ANY SEEPAGE OR EFFLORESCENCE	Efflorescence present on downstream channel walls.
DRAIN HOLES	None observed
C. DISCHARGE CHANNEL:	
GENERAL CONDITION	Channel between spillway and service bridge is narrow concrete lined
LOOSE ROCK OVERHANGING CHANNEL	None observed
TREES OVERHANGING CHANNEL	None until after service bridge
FLOOR OF CHANNEL	Floor of concrete channel deteriorated
OTHER OBSTRUCTIONS	Downstream of service bridge channel is overgrown with brush

PERIODIC INSPECTION CHECK LIST

PROJECT: BRISTOL RESERVOIR NO. 2 DAM DATE: 28 April 1981

PROJECT FEATURE: OUTLET WORKS - SERVICE BRIDGE NAME: RH

DISCIPLINE: CIVIL ENGINEERS NAME: DLS, RGL

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SERVICE BRIDGE	
A. SUPER STRUCTURE:	
BEARINGS	Concrete deck bears on walls of spillway channel
ANCHOR BOLTS	N/A
BRIDGE SEAT	N/A
LONGITUDINAL MEMBERS	Concrete deck
UNDER SIDE OF DECK	Good
SECONDARY BRACING	N/A
DECK	Good
DRAINAGE SYSTEM	N/A
RAILINGS	N/A
EXPANSION JOINTS	N/A
PAINT	N/A
B. ABUTMENT AND PIERS:	
GENERAL CONDITION OF CONCRETE	Concrete deck bears on walls of spillway channel, gunite cracked.
ALIGNMENT OF ABUTMENT	Good
APPROACH TO BRIDGE	Good
CONDITION OF SEAT AND BACKWALL	N/A

APPENDIX B

ENGINEERING DATA

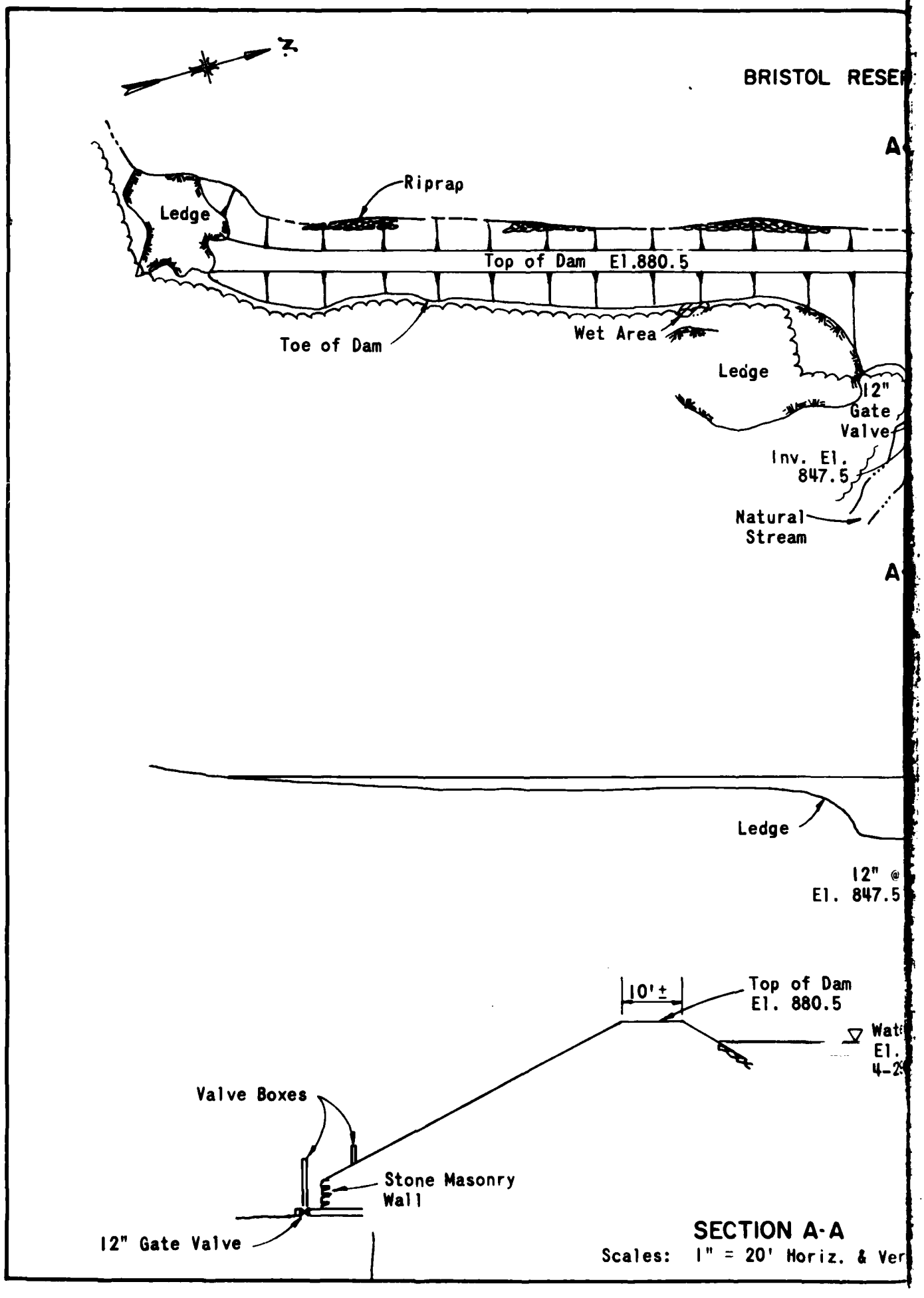
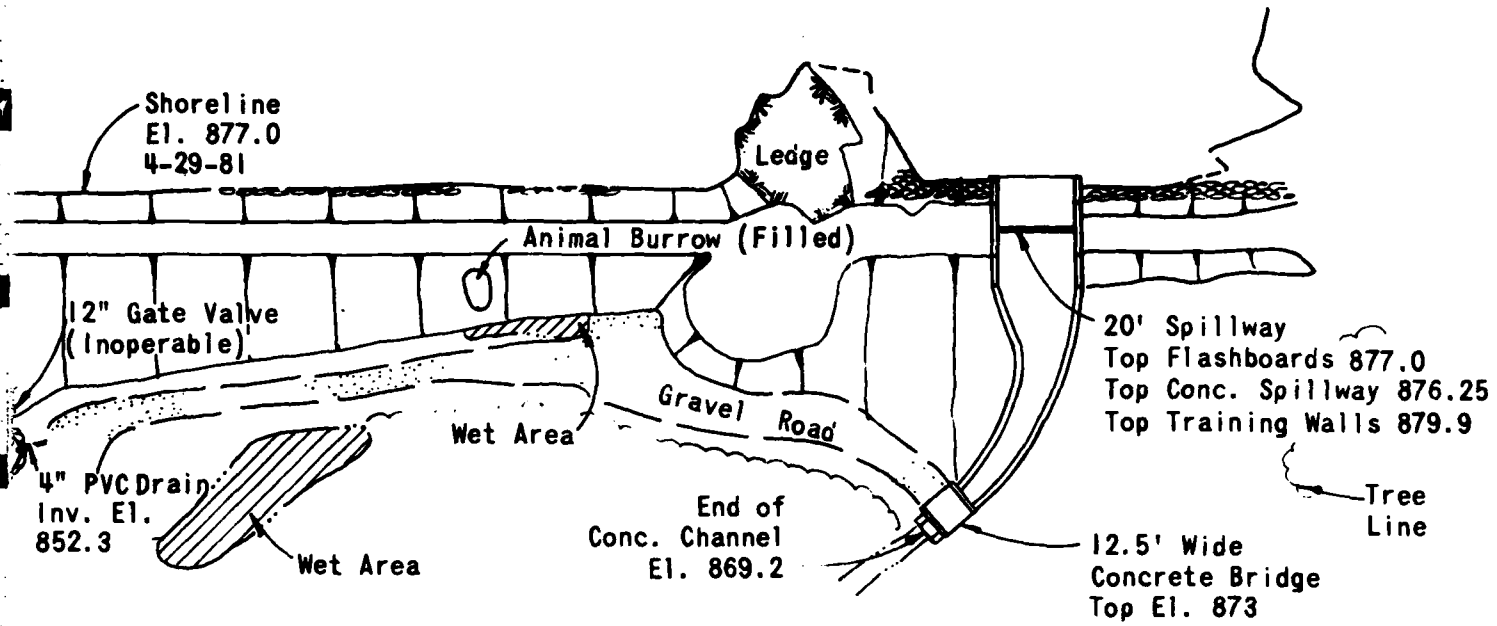
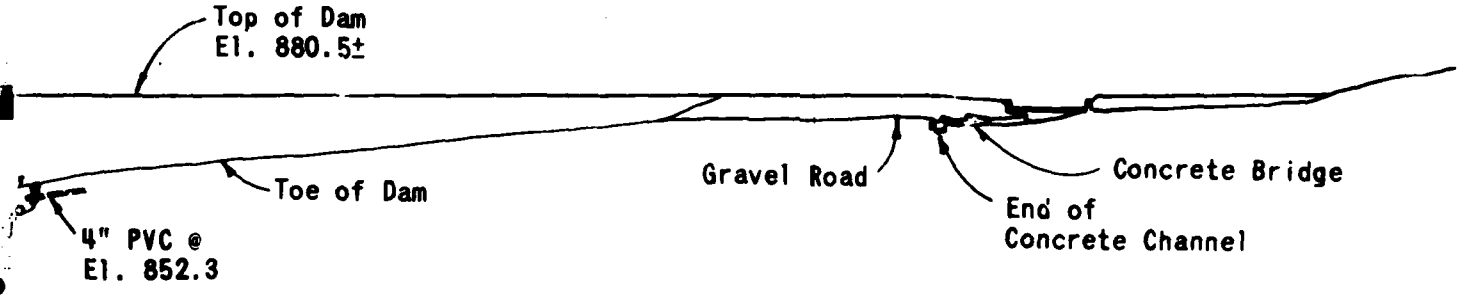

N
BRISTOL RESE
A
Riprap
Ledge
Top of Dam El.880.5
Toe of Dam
Wet Area
Ledge
12"
Gate
Valve
Inv. El.
847.5
Natural
Stream
A
Ledge
12" @
El. 847.5
10'±
Top of Dam
El. 880.5
Wat
El.
4-2
Valve Boxes
Stone Masonry
Wall
12" Gate Valve
SECTION A-A
Scales: 1" = 20' Horiz. & Ver

FIGURE 2

R NO. 2



PLAN
Scale: 1" = 50'



ELEVATION
Scales: 1" = 50' Horiz. & Vert.

Surface
7.0
1

TE: THE WATER SURFACE ELEVATION SHOWN ON THE 1969 THOMASTON U.S.G.S. QUADRANGLE MAP WAS ASSUMED TO BE THE ELEVATION AT TOP OF FLASHBOARDS. ALL OTHER ELEVATIONS ARE BASED ON THE ASSUMED ELEVATION AT THE TOP OF FLASHBOARDS.

ROALD HAESTAD, INC CONSULTING ENGINEERS WATERBURY, CONNECTICUT	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

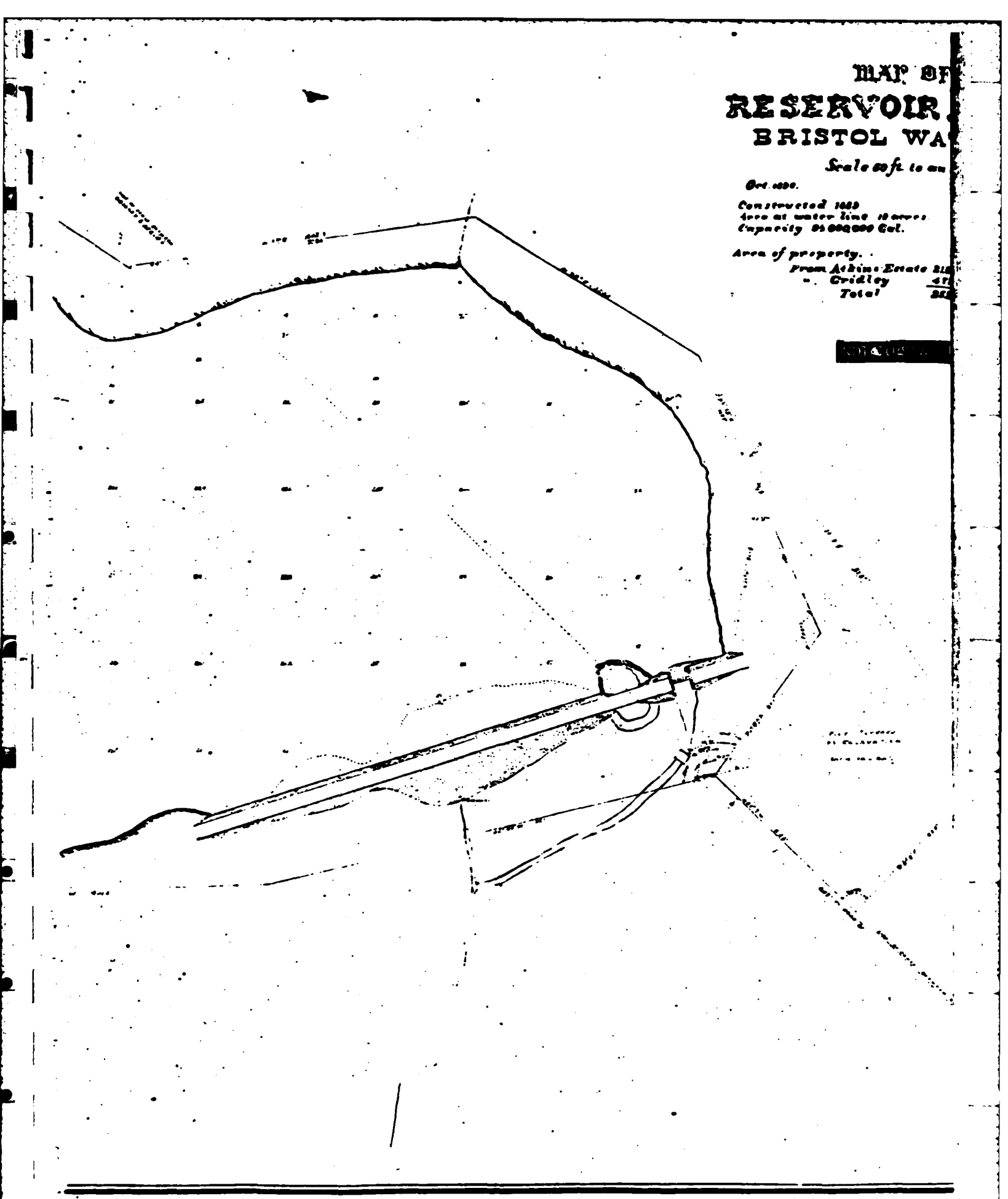
BRISTOL RESERVOIR NO 2 DAM

DRAWN	CHECKED	APPROVED	SCALES AS NOTED
JRS	RGL	RH	DATE 5/81 PAGE B-1

LIST OF REFERENCES

The following reference is located at the Bristol Water Department, 119 Riverside Street, Bristol, Connecticut 06010.

Map of Reservoir No. 2, Bristol Water Co., Scale 50 ft. to an inch, October 1890, R.D. Barnes, C.E.


MAP OF
RESERVOIR
BRISTOL WA
Scale 60 ft. to an
Oct. 1890.
Constructed 1869
Area at water line 18 acres
Capacity 95,000,000 Gal.
Area of property. .
From Atkins Estate 21
" Cridley 47
Total 26

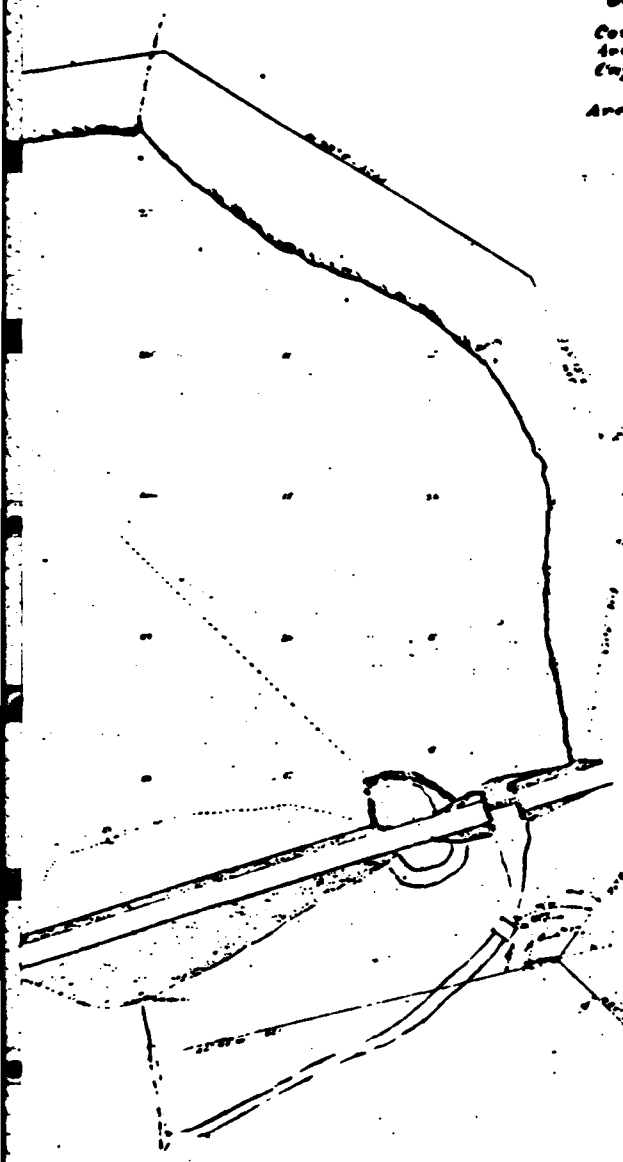
MAP OF
RESERVOIR. NO. 2.
BRISTOL WATER CO.

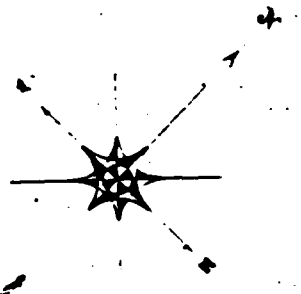
Scale 80 ft. to an inch

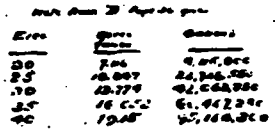
Dec. 1880.

Constructed 1880
Area at water line 10 acres.
Capacity 85,000,000 Gal.

Area of property. .
From Atkins Estate 21.81 acres.
" Cridley 4.72 "
Total 25.53 "





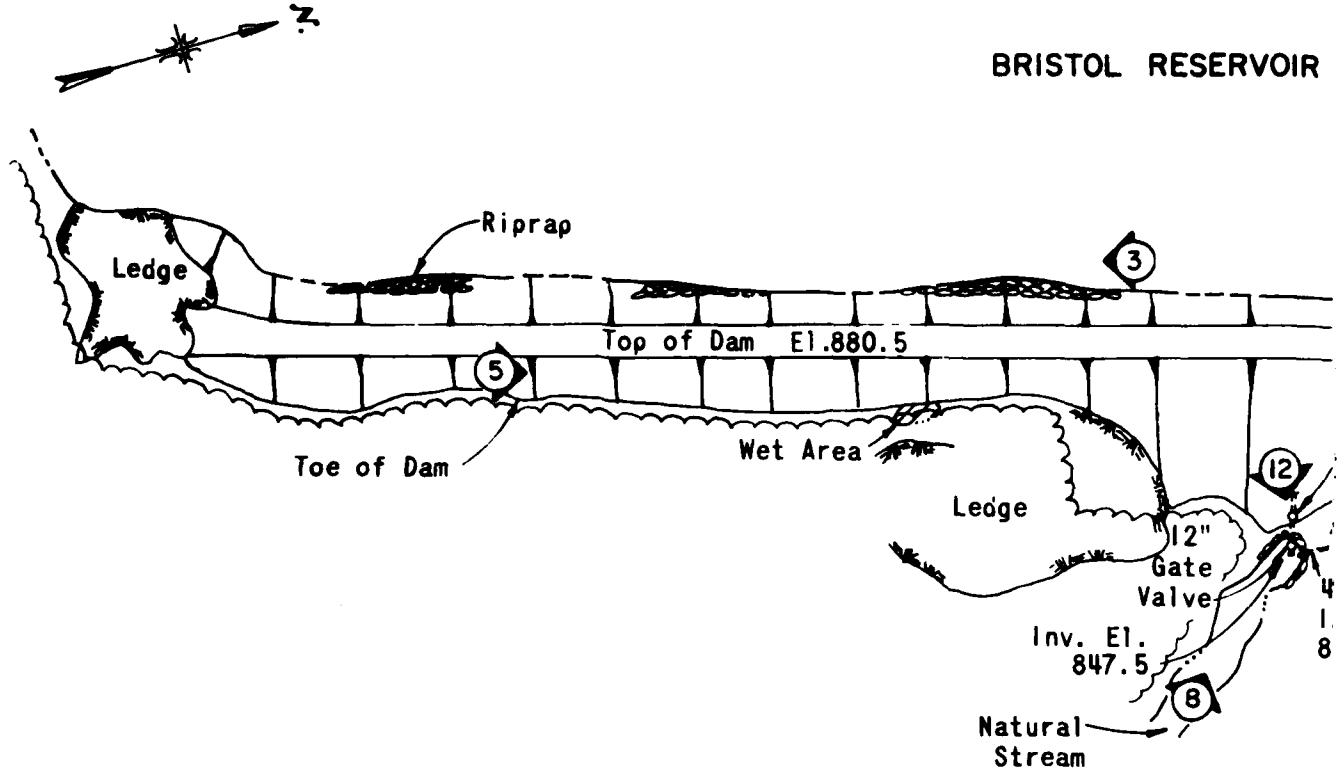


2

APPENDIX C

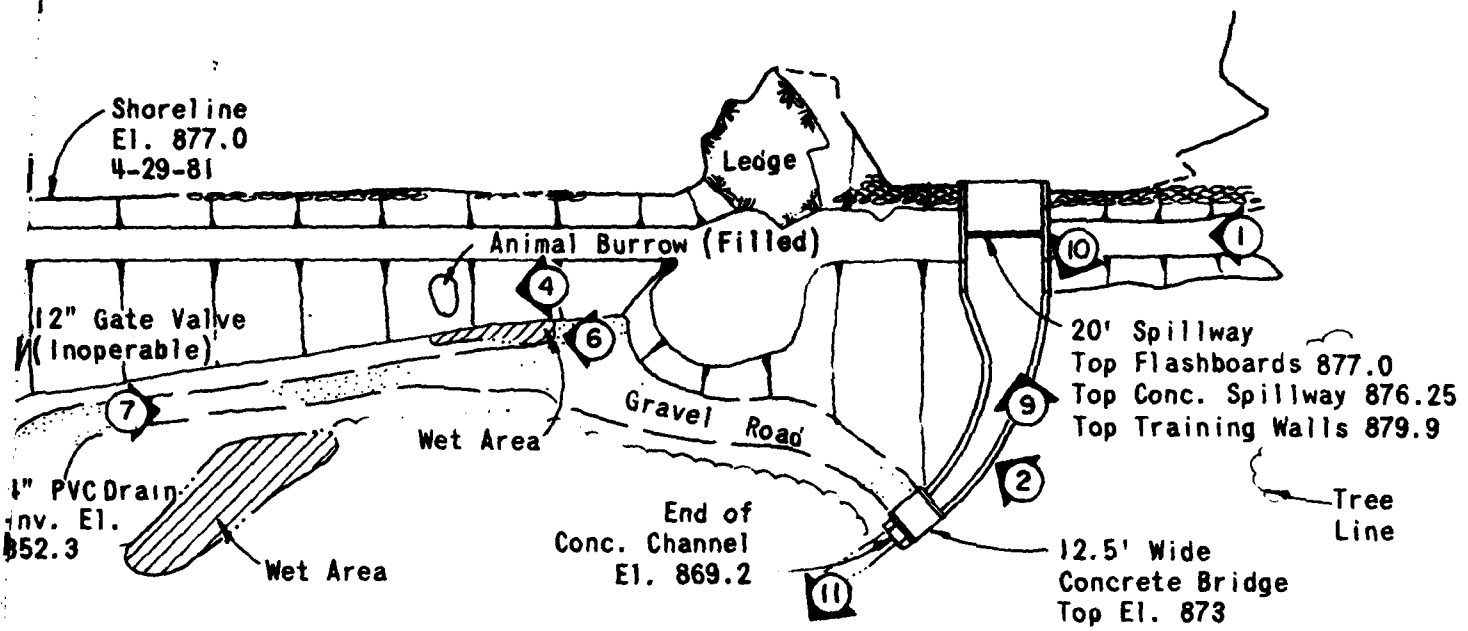
PHOTOGRAPHS

BRISTOL RESERVOIR



Denotes photo number and direction in which photo was taken

10. 2



2

ROALD HAESTAD, INC CONSULTING ENGINEERS WATERBURY, CONNECTICUT	US ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

PHOTO LOCATION PLAN
BRISTOL RESERVOIR NO. 2 DAM
HARWINTON, CONNECTICUT

DRAWN	CHECKED	APPROVED	SCALES	DATE	PAGE
JRS	RGT	RH	1" = 40'	5/81	C-1

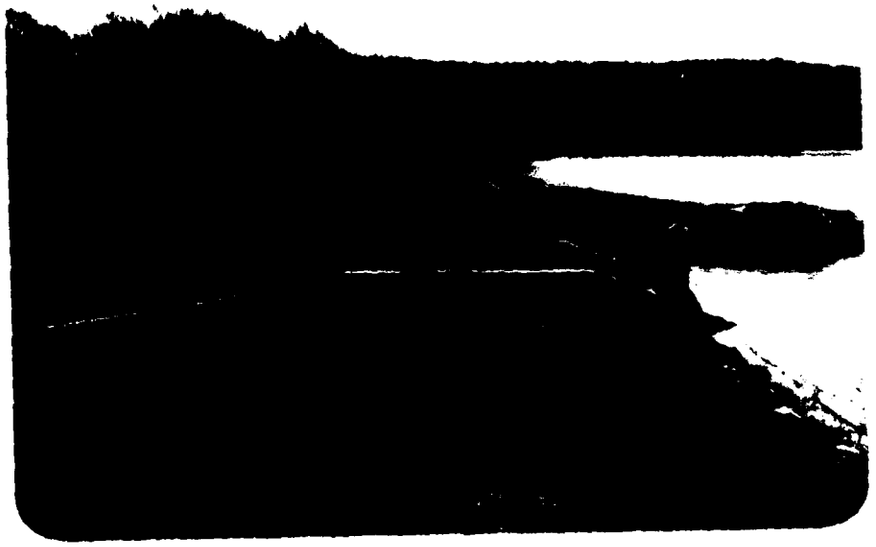


PHOTO NO. 1

DAM AND SPILLWAY FROM LEFT ABUTMENT.
NOTE LEDGE OUTCROP BEYOND SPILLWAY.

PHOTO NO. 2

DOWNSTREAM SLOPE OF DAM.

U.S.ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BRISTOL RES. NO. 2 DAM TR. TO POLAND RIVER HARWINTON, CONNECTICUT CT 00365 28 APRIL '81
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

PHOTO NO. 3

UPSTREAM SLOPE OF DAM. RIPRAP IN FOREGROUND IS ON TOP OF LEDGE OUTCROP.

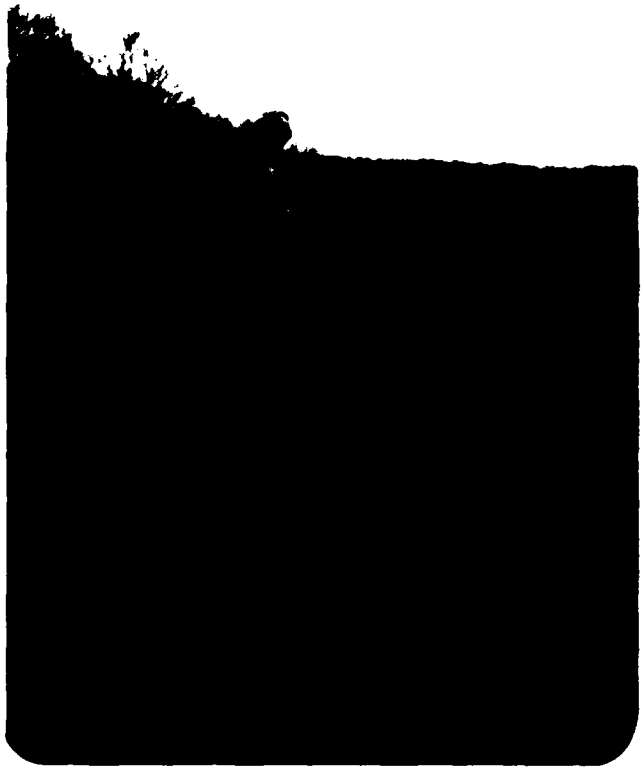


PHOTO NO. 4

DOWNSTREAM SLOPE OF DAM. NOTE REMAINS OF FORMER ANIMAL BURROW.

U.S.ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BRISTOL RES. NO. 2 DAM TR. TO POLAND RIVER HARWINTON, CONNECTICUT CT 00365 28 APRIL '81
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

PHOTO NO. 5

CREST AND DOWNSTREAM SLOPE FROM RIGHT END OF DAM. NOTE TREES DOWNSTREAM OF DAM.

PHOTO NO. 6

WET AREA AT DOWNSTREAM TOE OF DAM.

U.S.ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BRISTOL RES. NO. 2 DAM TR. TO POLAND RIVER HARWINTON, CONNECTICUT CT 00365 28 APRIL '81
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

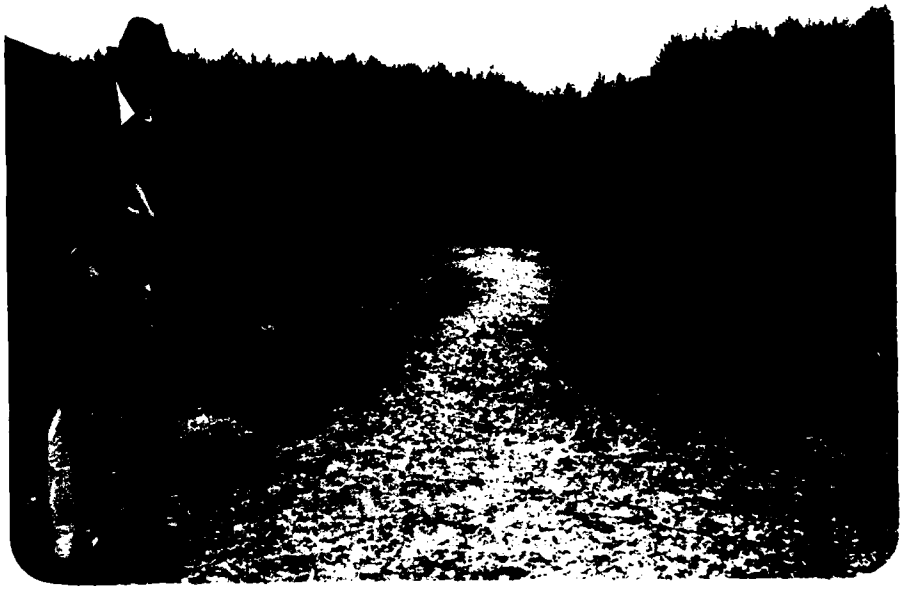


PHOTO NO. 7

DRAIN AT DOWNSTREAM TOE. AREA TO THE RIGHT IS WET.

PHOTO NO. 8

STONE MASONRY WALL AT OUTLET END OF LOW LEVEL OUTLET OR BLOWOFF. NOTE OPERATOR FOR GATE VALVE AND 2-3 GPM DISCHARGE FROM DOWNSTREAM DRAIN AT RIGHT.

U.S.ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BRISTOL RES. NO. 2 DAM TR. TO POLAND RIVER HARWINTON, CONNECTICUT CT 00365 28 APRIL '81
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

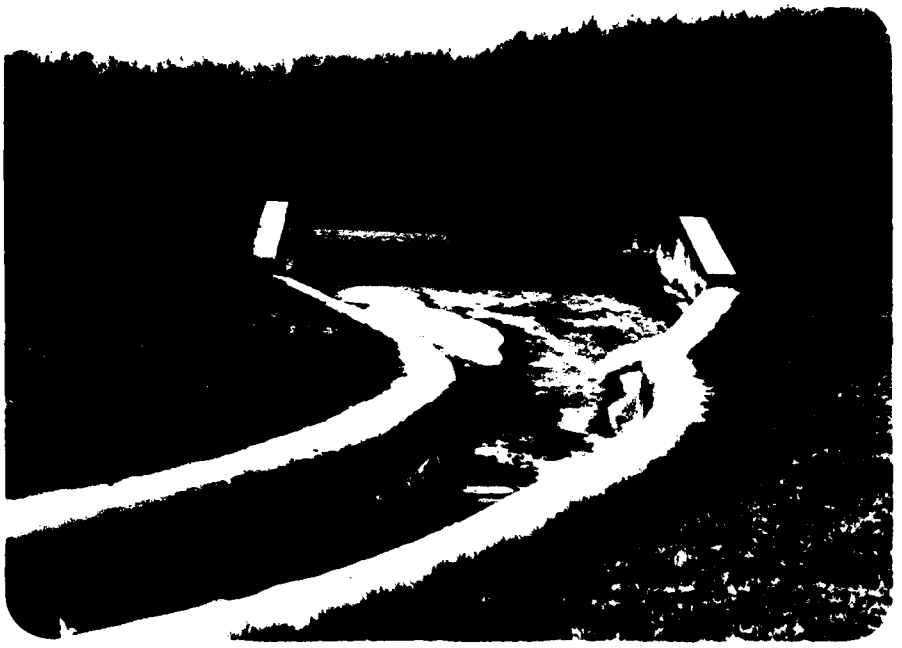


PHOTO NO. 9

SPILLWAY FROM DOWNSTREAM. NOTE FLASHBOARDS.

PHOTO NO. 10

SPILLWAY DISCHARGE CHANNEL. NOTE DOWNSTREAM BRIDGE, EFFLORESCENCE AND CRACKING OF GUNITE ON WALLS, AND DETERIORATION OF FLOOR.

U.S.ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BRISTOL RES. NO. 2 DAM TR. TO POLAND RIVER HARWINTON, CONNECTICUT CT 00365 28 APRIL '81
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

PHOTO NO. 11

SPILLWAY DISCHARGE CHANNEL
DOWNSTREAM OF SERVICE BRIDGE.

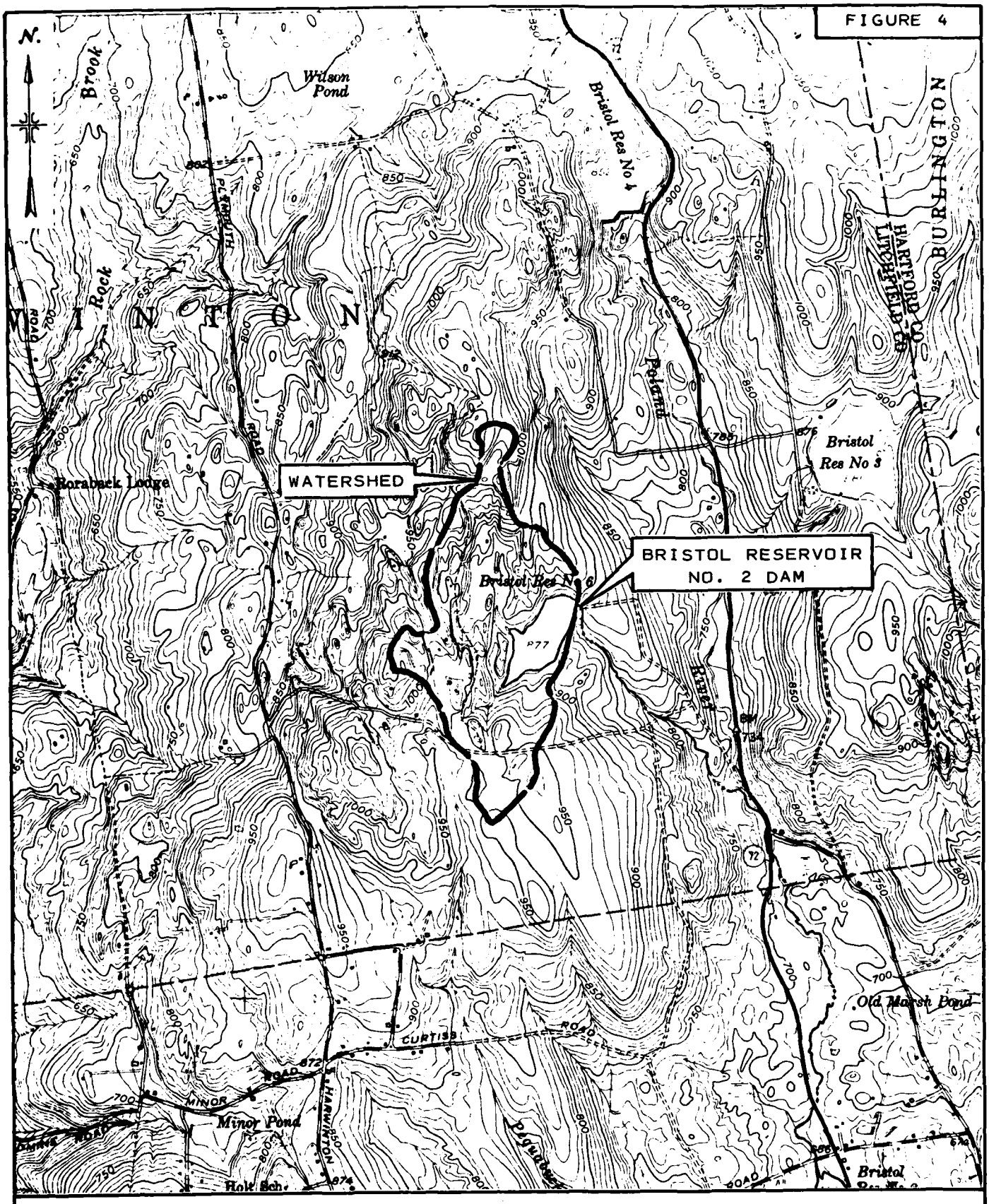
PHOTO NO. 12

DISCHARGE CHANNEL FOR LOW LEVEL OUTLET OR BLOWOFF.
NOTE THE TWO EXTENSION BOXES FOR GATES.
THE ONE AT EXTREME RIGHT IS REPORTED TO BE INOPERABLE.

U.S.ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BRISTOL RES. NO. 2 DAM TR. TO POLAND RIVER HARWINTON, CONNECTICUT CT 00365 28 APRIL '81
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



WATERSHED MAP

BRISTOL RESERVOIR NO. 2 DAM
HARWINTON, CONNECTICUT

SCALE: 1" = 2000'

ROALD HAESTAD, INC.

THOMASTON QUADRANGLE 1969

BY SAL DATE 5/25/81 **ROALD HAESTAD, INC.** SHEET NO 1 OF 3

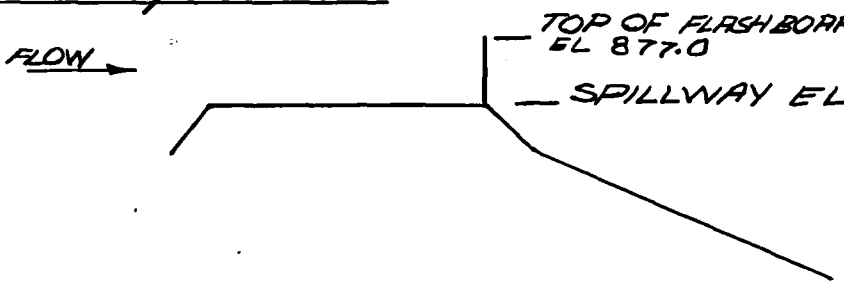
CONSULTING ENGINEERS

CKD BY DL DATE 5/26/81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-044

SUBJECT BRISTOL RESERVOIR NO. 2 - Project discharge capacity

Spillway Section:

Scale 1" = 2' Vert
1" = 10' Horiz

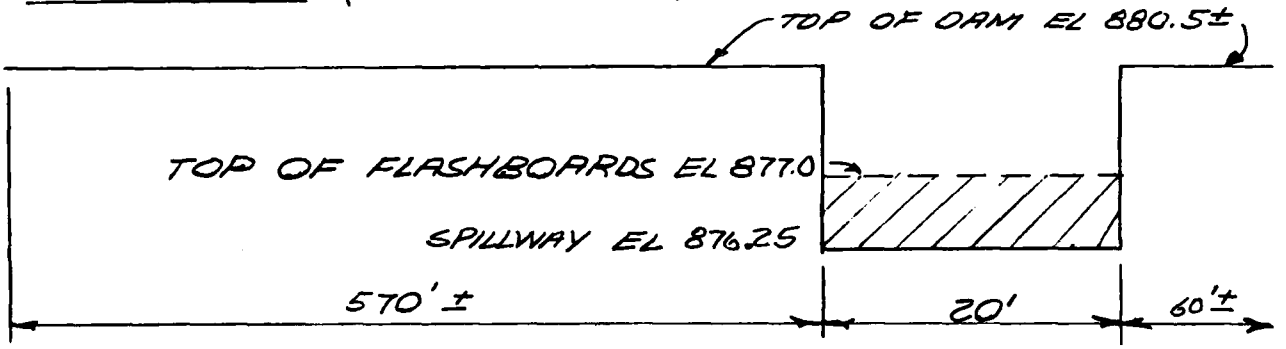


L = 20'
C = 2.63

Flashboard discharge coefficient = 3.3

$Q = CLH^{3/2}$

Dam Profile: (Not to Scale)



Embankment Discharge Coefficient = 2.8

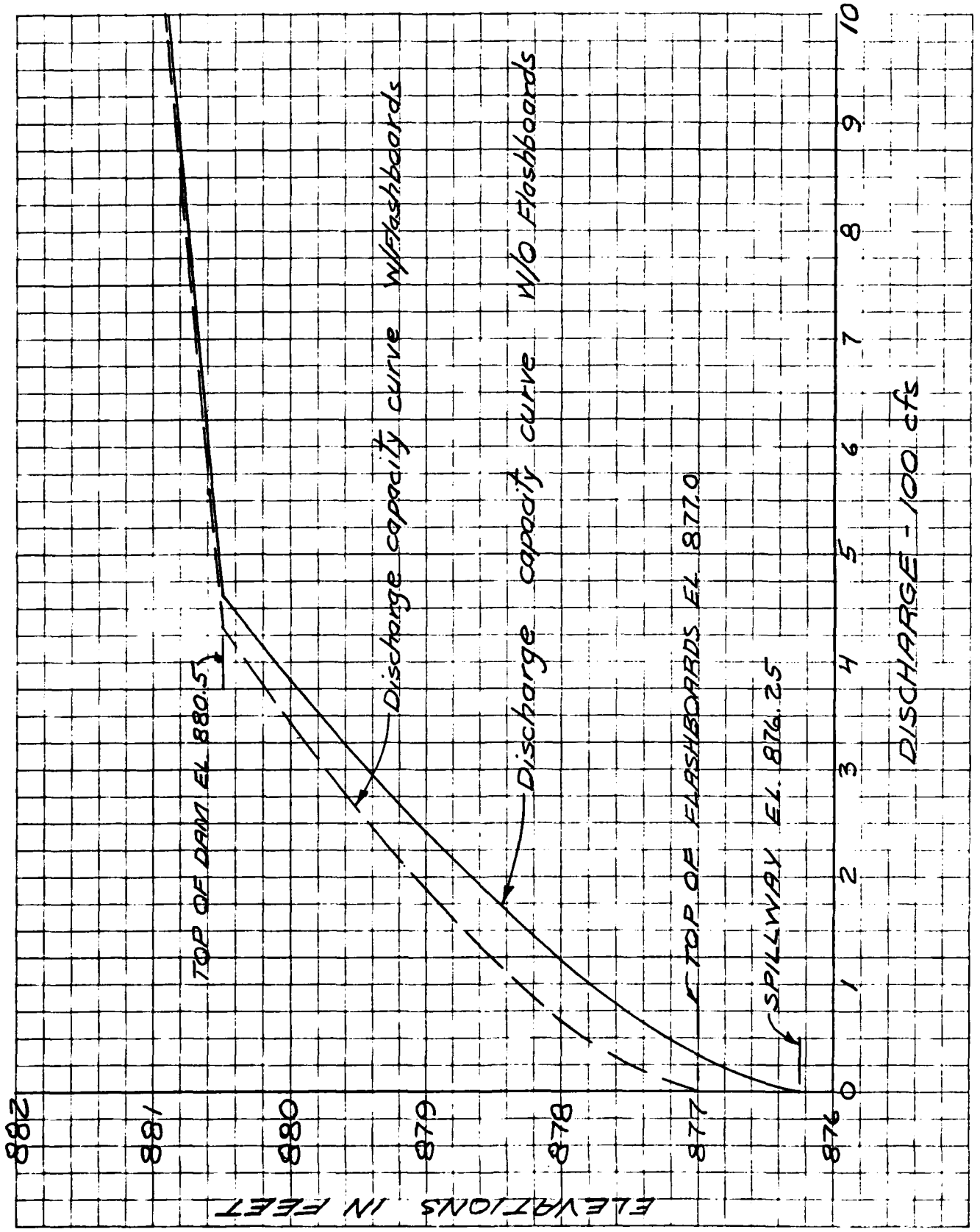
	W/FLASHBOARDS			W/O FLASHBOARDS		
ELEV. (feet)	Spillway (cfs)	Dam (cfs)	Total Disch. Cap. -cfs	Spillway (cfs)	Dam (cfs)	Total Disch. Cap. -cfs
876.25	0	0	0	0	0	0
877.0	0	0	0	34	0	34
878.0	66	0	66	122	0	122
879.0	187	0	187	240	0	240
880.0	343	0	343	382	0	382
880.5	432	0	432	461	0	461
881.0	528	624	1152	545	624	1169
882.0	738	3241	3979	725	3241	3966

BY SAL DATE 5/25/81 **ROALD HAESTAD, INC.** SHEET NO 2 OF 5

CONSULTING ENGINEERS

CKD BY RLS DATE 5/26/81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49 044

SUBJECT BRISTOL RESERVOIR NO. 2 - Project discharge capacity



BY SAL DATE 5/13/81 **ROALD HAESTAD, INC.** SHEET NO 3 OF 5

CONSULTING ENGINEERS

CKD BY [illegible] DATE [illegible] 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-044

SUBJECT BRISTOL RESERVOIR NO. 2 - Surcharge storage capacity

ELEV. (feet)	Surface Area (Acres)	Average Surface Area (Acres)	Surcharge Storage Capacity (Acre-Feet)	
			W/O Flashboards	W/Flashboards
876.25	19 *		0	0
		19.12		
877	19.24		14	0
		19.40		
878	19.56		34	19
		19.72		
879	19.88		53	39
		20.04		
880	20.2		74	59
		20.39		
880.5	20.57		84	69
		20.75		
881	20.93		94	80
		21.30		
882	21.66		115	101
		22.39		
884	23.12		160	146
		23.85		
886	24.58		208	194
		25.31		
888	26.04		258	244
		26.77		
890	27.5		312	298

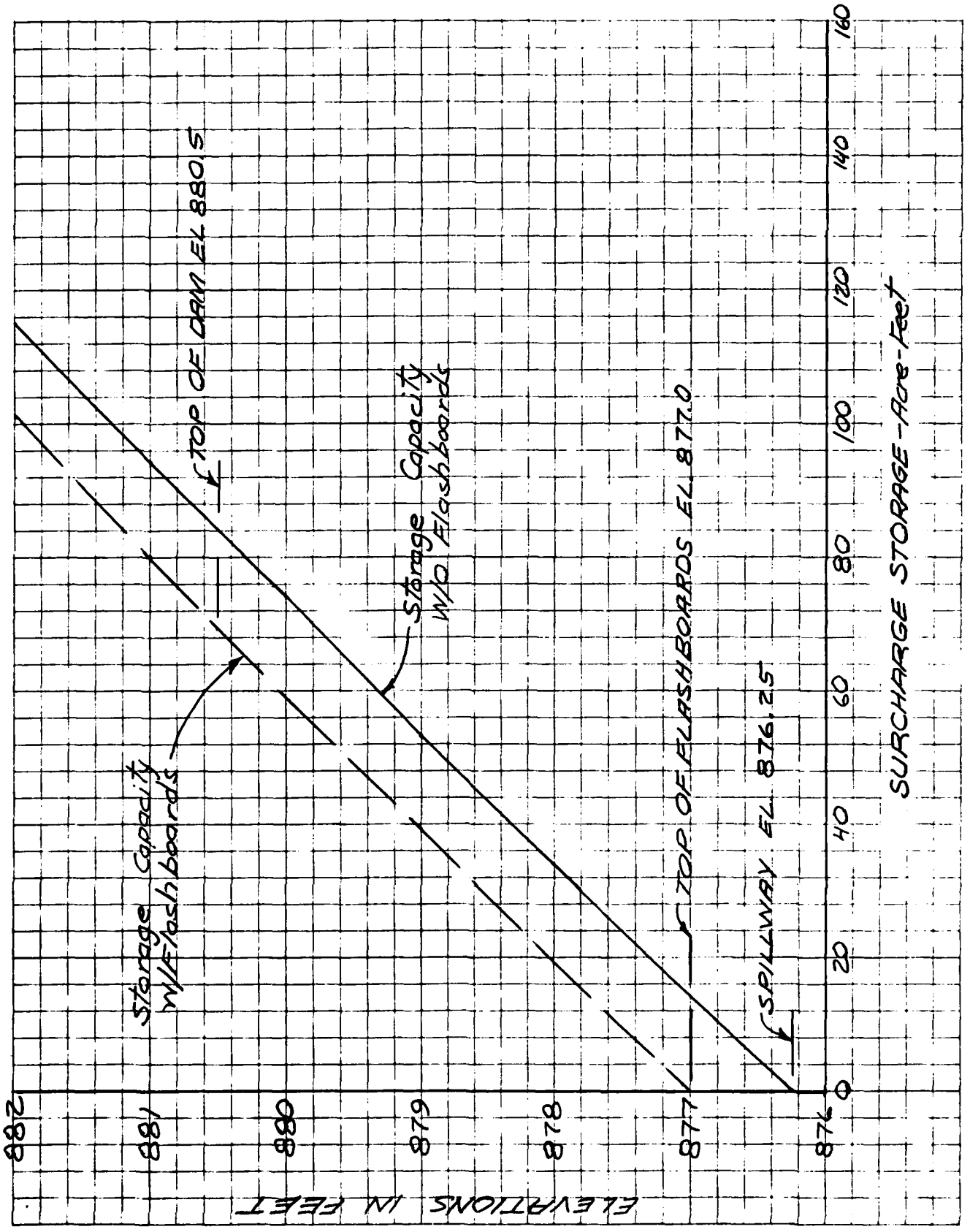
* The surface area at spillway level was supplied by the Bristol Water Department.

BY SAL DATE 5/25/81 **ROALD HAESTAD, INC.** SHEET NO 4 OF 5

CONSULTING ENGINEERS

CKD BY DLS DATE 5/26/81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-044

SUBJECT BRISTOL RESERVOIR NO. 2 - Surcharge storage capacity



BY SAL DATE 5/26/81 **ROALD HAESTAD, INC.** SHEET NO 5 OF 31

CONSULTING ENGINEERS

CKD BY DLS DATE 5/27/81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-044

SUBJECT BRISTOL RESERVOIR NO 2 - Test Flood

TEST FLOOD - ½ PMF

Drainage Area = 199 Acres = 0.31 sq. mi.

From Corps of Eng. chart for "Rolling" Terrain

MPF = 2,125 cfs/sq. mi. (2.0 sq. mi. Minimum)

PMF = 2,125 cfs/sq. mi. × 0.31 sq. mi. = 659 cfs

½ PMF = ½ (659) = 329.5 use 330 cfs

Q_{P1} = 330 cfs

Note: The flood routing for the test flood was done with the flashboards in place.

H_1 = 2.9 ft above flashboards, from Discharge curve

$STOR_1$ = 57 ac-ft, from Storage Capacity Curve

= 3.4" runoff from 0.31 sq. mi

Note: PMF runoff in New England equals approx. 19". Therefore ½ PMF runoff equals approx. ½(19") = 9.5".

$Q_{P2} = Q_{P1}(1 - STOR_1/9.5) = 330 \text{ cfs}(1 - 3.4/9.5) = 212$ cfs

H_2 = 2.2 ft $STOR_2$ = 43 ac-ft

$STOR_{AVE} = (STOR_1 + STOR_2)/2 = (57 + 43)/2 = 50$ ac-ft
= 3.0 inches of runoff

$Q_{P3} = Q_{P1}(1 - STOR_{AVE}/9.5) = 330 \text{ cfs}(1 - 3/9.5) = 225$ cfs

H_3 = 2.25' use 2.3 ft

Spillway Capacity W/Flashboards = 432 cfs (Top of dam) use 430 cfs

% of ½ PMF = (430/225) × 100 = 191% of ½ PMF

S = Storage at time of failure with water level at top of dam.

S = Storage at Flashboard level + Surcharge storage

$S = \left[105.2 \times 10^6 \text{ gal} \times \frac{1 \text{ Ac-Ft}}{325{,}851 \text{ gal}}\right]^* + 69 \text{ Ac-Ft}$ (From Surcharge Storage Capacity Curve)

S = 322.8 Ac-Ft + 69 Ac-Ft

S = 391.8 use 400 Ac-Ft

* The storage capacity at flashboard level was supplied by the Bristol Water Department.

$Q_{pl} = 8/27\ W_b \sqrt{g}\ Y_o^{3/2}$ = Peak Failure Outflow

W_b = Breach width - 40% of dam length across river at mid-height = 0.4 (125) = 50'

Y_o = Total height from river bed to pool level at time of failure = 33'

$Q_{pl} = 8/27\ (50) \sqrt{32.2}\ (33)^{3/2}$

= 15,936.6 use 16,000 cfs

BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 7 OF 3[illegible]

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 1A

MAIN CHANNEL

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
1.0	19	15	0.81	0.0369	6.22	96
2.0	24	37	1.50	0.0369	9.35	342
3.0	30	63	2.11	0.0369	11.73	734
4.0	35	94	2.67	0.0369	13.73	1284
5.0	40	129	3.20	0.0369	15.51	2007
6.0	45	170	3.75	0.0369	17.22	2931
7.0	47	214	4.51	0.0369	19.47	4169
8.0	50	260	5.24	0.0369	21.53	5593
9.0	52	307	5.95	0.0369	23.43	7201
10.0	55	357	6.49	0.0369	24.83	8870
11.0	59	411	6.97	0.0369	26.04	10694
12.0	63	468	7.45	0.0369	27.21	12738
13.0	67	529	7.93	0.0369	28.37	15012

MANNING COEFFICIENT=N=0.0400

BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 8 OF 3?

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 1B

LEFT OVERBANK

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
6.0	2		0.05	0.0369	0.39	
7.0	21	11	0.55	0.0369	1.91	22
8.0	40	42	1.05	0.0369	2.95	123
9.0	59	91	1.55	0.0369	3.82	347
10.0	78	159	2.05	0.0369	4.60	731
11.0	96	246	2.55	0.0369	5.32	1308
12.0	115	351	3.05	0.0369	6.00	2108
13.0	124	472	3.79	0.0369	6.94	3279

MANNING COEFFICIENT=N=0.1000

BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 9 OF 36

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 1

TOTAL SECTION

	AREA (SQ.FT.)			DISCHARGE (CFS)		
H	A	B	TOTAL	A	B	TOTAL
1.0	15	0	15	96	0	96
2.0	37	0	37	342	0	342
3.0	63	0	63	734	0	734
4.0	94	0	94	1284	0	1284
5.0	129	0	129	2007	0	2007
6.0	170	0	170	2931	0	2931
7.0	214	11	226	4169	22	4191
8.0	260	42	301	5593	123	5716
9.0	307	91	398	7201	347	7547
10.0	357	159	516	8870	731	9600
11.0	411	246	656	10694	1308	12001
12.0	468	351	820	12738	2108	14846
13.0	529	472	1001	15012	3279	18290

STORAGE AT TIME OF FAILURE=S= 400 AC. FT.
LENGTH OF REACH=L= 4000 FT

INFLOW INTO REACH=QP1= 16000 CFS
DEPTH OF FLOW=H1= 12.3 FT.
CROSS SECTIONAL AREA=A1= 880 SQ.FT.
STORAGE IN REACH=V1= 80.8 AC. FT.

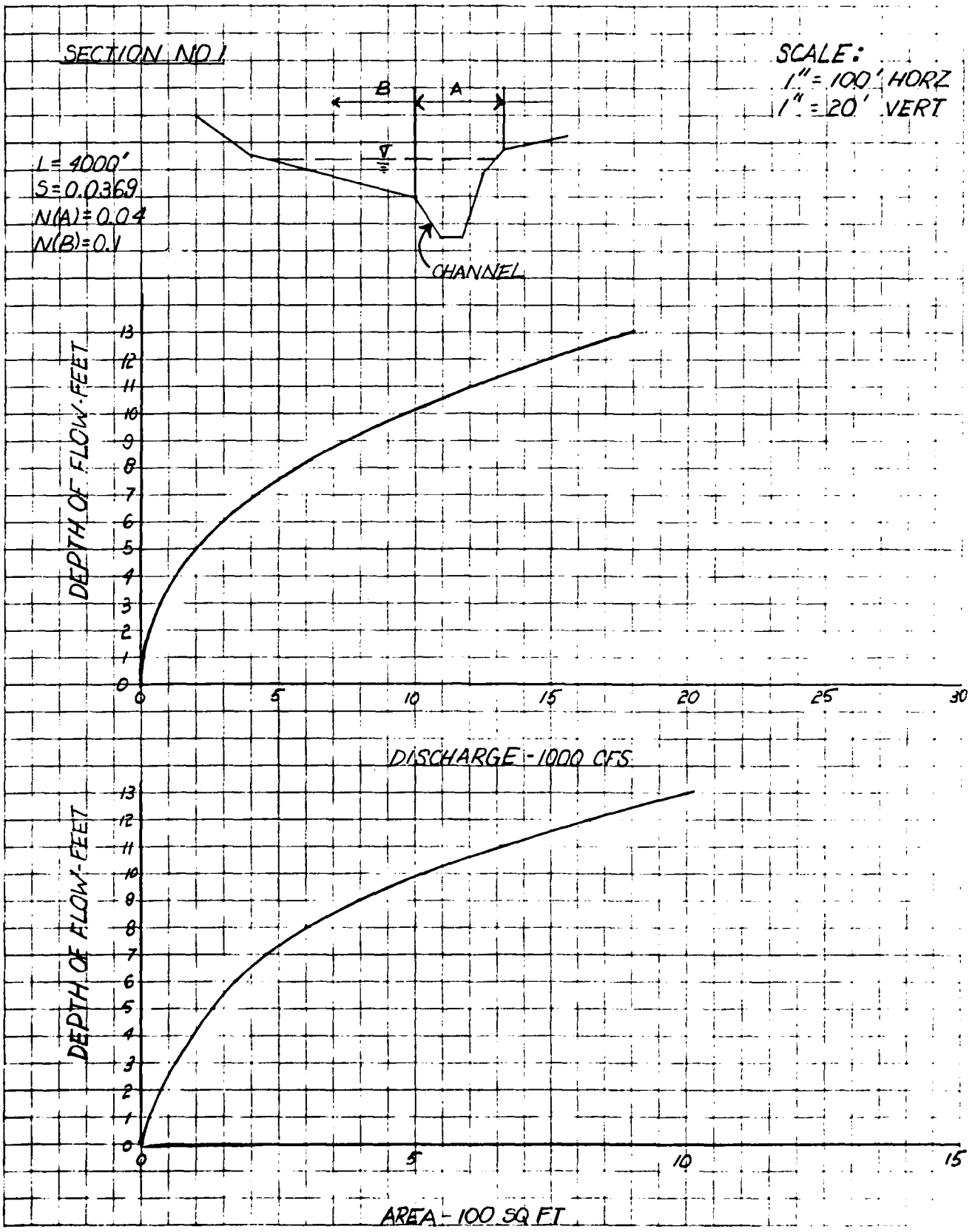
TRIAL REACH OUTFLOW=QP(TRIAL)= 12766 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 11.3 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 700 SQ.FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 64.3 AC. FT.

REACH OUTFLOW=QP2= 13097 CFS
DEPTH OF FLOW=H2= 11.4 FT.

BY PAM DATE 5-20-81 **ROALD HAESTAD, INC.** SHEET NO 12 OF .....

CKD BY SAL DATE 5/25/81 CONSULTING ENGINEERS 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 049-044

SUBJECT BRISTOL RESERVOIR NO. 2 FLOOD ROUTING



BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO. 1 OF 3

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 2A

MAIN CHANNEL

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
1.0	18	9	0.50	0.0180	1.25	11
2.0	35	35	0.99	0.0180	1.98	69
3.0	53	79	1.49	0.0180	2.60	205
4.0	71	140	1.98	0.0180	3.15	441
5.0	88	219	2.48	0.0180	3.65	799
6.0	106	315	2.98	0.0180	4.13	1299
7.0	123	429	3.47	0.0180	4.57	1960
8.0	141	560	3.97	0.0180	5.00	2799
9.0	159	709	4.46	0.0180	5.41	3831
10.0	176	875	4.96	0.0180	5.80	5074
11.0	186	1055	5.66	0.0180	6.33	6679
12.0	196	1245	6.34	0.0180	6.83	8499
13.0	207	1445	7.00	0.0180	7.29	10538
14.0	217	1655	7.64	0.0180	7.73	12801
15.0	227	1875	8.27	0.0180	8.16	15291

MANNING COEFFICIENT=N=0.1000

BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 12 OF 30

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 2B

RIGHT OVERBANK

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
9.0	41	33	0.82	0.0180	2.18	73
10.0	53	80	1.51	0.0180	3.29	264
11.0	65	139	2.14	0.0180	4.13	577
12.0	77	211	2.72	0.0180	4.86	1023
13.0	90	294	3.28	0.0180	5.50	1618
14.0	102	389	3.83	0.0180	6.10	2375
15.0	114	497	4.36	0.0180	6.65	3308

MANNING COEFFICIENT=N=0.0800

BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 13 OF 35

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 2

TOTAL SECTION

	AREA (SQ.FT.)			DISCHARGE (CFS)		
H	A	B	TOTAL	A	B	TOTAL
1.0	9	0	9	11	0	11
2.0	35	0	35	69	0	69
3.0	79	0	79	205	0	205
4.0	140	0	140	441	0	441
5.0	219	0	219	799	0	799
6.0	315	0	315	1299	0	1299
7.0	429	0	429	1960	0	1960
8.0	560	0	560	2799	0	2799
9.0	709	33	742	3831	73	3904
10.0	875	80	955	5074	264	5338
11.0	1055	139	1194	6679	577	7256
12.0	1245	211	1456	8499	1023	9523
13.0	1445	294	1739	10538	1618	12156
14.0	1655	389	2044	12801	2375	15176
15.0	1875	497	2372	15291	3308	18599

STORAGE AT TIME OF FAILURE=S= 400 AC. FT.
LENGTH OF REACH=L= 2000 FT

INFLOW INTO REACH=QP1= 13097 CFS
DEPTH OF FLOW=H1= 13.3 FT.
CROSS SECTIONAL AREA=A1= 1834 SQ.FT.
STORAGE IN REACH=V1= 84.2 AC. FT.

TRIAL REACH OUTFLOW=QP(TRIAL)= 10340 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 12.3 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 1544 SQ.FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 70.9 AC. FT.

REACH OUTFLOW=QP2= 10558 CFS
DEPTH OF FLOW=H2= 12.4 FT.

BY PAM DATE 5-20-81 **ROALD HAESTAD, INC.** SHEET NO 14 OF 31

CONSULTING ENGINEERS

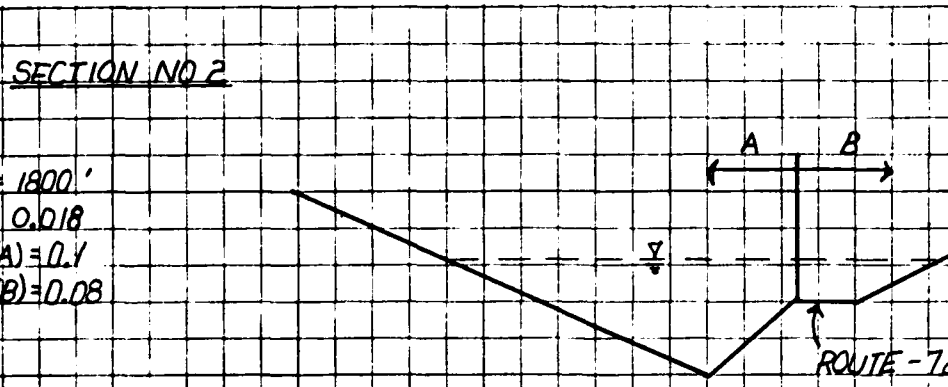
CKD BY SAL DATE 5/25/81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 049-044

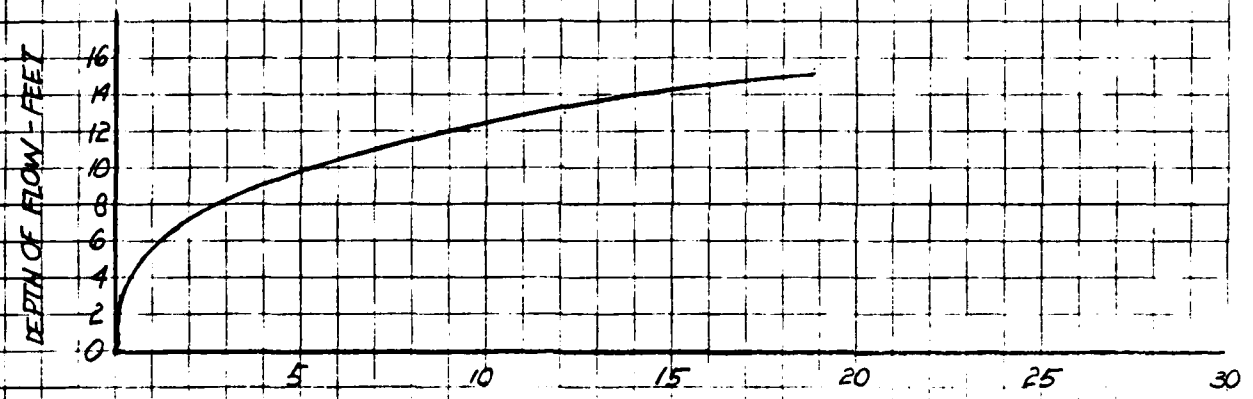
SUBJECT BRISTOL RESERVOIR NO 2 - FLOOD ROUTING

SECTION NO 2

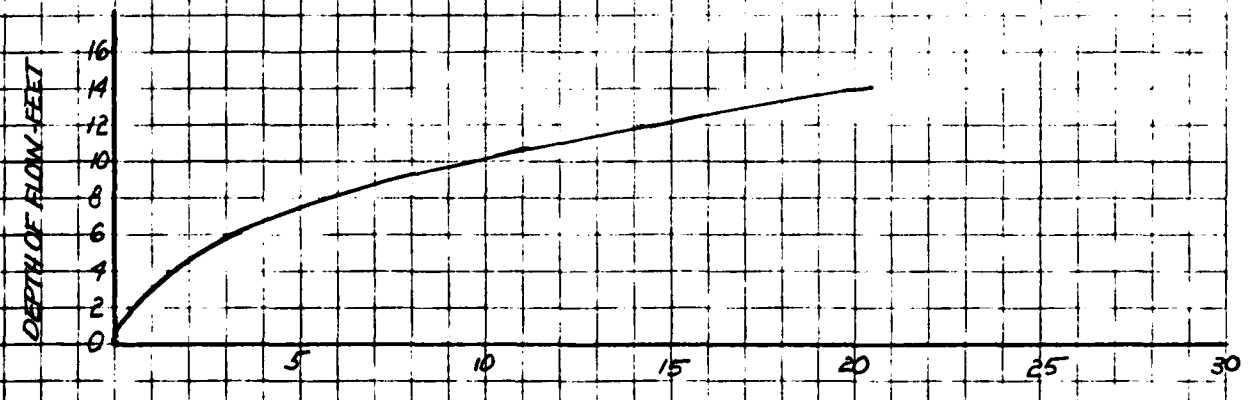
SCALE:
1" = 100' HORZ
1" = 20' VERT

L = 1800'
S = 0.018
N(A) = 0.1
N(B) = 0.08





DISCHARGE - 1000 CFS



AREA - 100 SQ FT

BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 15 OF 34

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 3

TOTAL SECTION

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
1.0	92	46	0.50	0.0024	0.46	21
2.0	183	183	1.00	0.0024	0.73	133
3.0	275	412	1.50	0.0024	0.95	393
4.0	343	721	2.11	0.0024	1.20	862
5.0	410	1098	2.68	0.0024	1.40	1540
6.0	478	1541	3.23	0.0024	1.59	2450
7.0	545	2052	3.76	0.0024	1.76	3616
8.0	613	2631	4.29	0.0024	1.92	5060
9.0	680	3277	4.82	0.0024	2.08	6806
10.0	748	3991	5.34	0.0024	2.22	8873
11.0	815	4772	5.85	0.0024	2.36	11284
12.0	883	5621	6.37	0.0024	2.50	14057
13.0	951	6537	6.88	0.0024	2.63	17212
14.0	1033	7529	7.29	0.0024	2.74	20602
15.0	1116	8602	7.71	0.0024	2.84	24443
16.0	1198	9759	8.14	0.0024	2.95	28759
17.0	1281	10998	8.59	0.0024	3.05	33572
18.0	1363	12319	9.04	0.0024	3.16	38906
19.0	1446	13723	9.49	0.0024	3.26	44783
20.0	1528	15209	9.95	0.0024	3.37	51223

MANNING COEFFICIENT=N=0.1000
STORAGE AT TIME OF FAILURE=S= 400 AC. FT.
LENGTH OF REACH=L= 1600 FT

INFLOW INTO REACH=QP1= 10558 CFS
DEPTH OF FLOW=H1= 10.7 FT.
CROSS SECTIONAL AREA=A1= 4537 SQ.FT.
STORAGE IN REACH=V1= 166.7 AC. FT.

TRIAL REACH OUTFLOW=QP(TRIAL)= 6159 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 8.6 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 3038 SQ.FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 111.6 AC. FT.

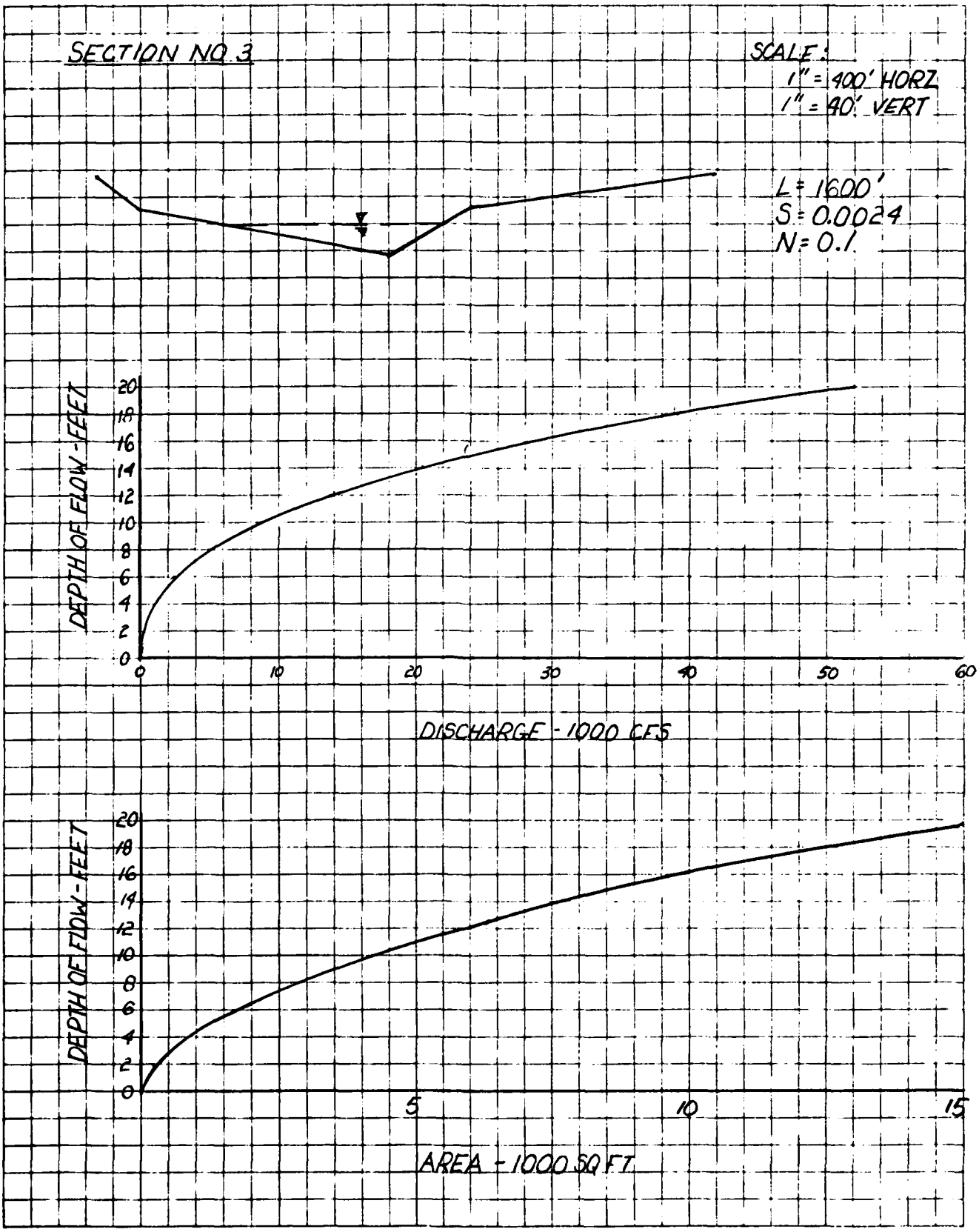
REACH OUTFLOW=QP2= 6886 CFS
DEPTH OF FLOW=H2= 9.0 FT.

BY PAM DATE 5-20-81 **ROALD HAESTAD, INC.** SHEET NO. 16 OF 34

CONSULTING ENGINEERS

CKD BY SAH DATE 5/25/81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO. 049-044

SUBJECT BRISTOL RESERVOIR NO 2 - FLOOD ROUTING



BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 17 OF 36

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 4

TOTAL SECTION

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
1.0	40	20	0.50	0.0024	0.46	9
2.0	80	80	1.00	0.0024	0.73	58
3.0	119	179	1.50	0.0024	0.95	171
4.0	159	318	2.00	0.0024	1.15	367
5.0	199	497	2.50	0.0024	1.34	666
6.0	239	716	3.00	0.0024	1.51	1083
7.0	279	974	3.50	0.0024	1.68	1634
8.0	319	1272	3.99	0.0024	1.83	2332
9.0	405	1632	4.03	0.0024	1.84	3010
10.0	440	2053	4.67	0.0024	2.03	4176
11.0	475	2510	5.29	0.0024	2.21	5545
12.0	510	3002	5.88	0.0024	2.37	7124
13.0	545	3529	6.47	0.0024	2.53	8922
14.0	581	4091	7.05	0.0024	2.68	10948
15.0	616	4689	7.61	0.0024	2.82	13211
16.0	651	5321	8.17	0.0024	2.95	15720
17.0	686	5989	8.73	0.0024	3.09	18482
18.0	721	6692	9.28	0.0024	3.21	21507

MANNING COEFFICIENT=N=0.1000
STORAGE AT TIME OF FAILURE=S= 400 AC. FT.
LENGTH OF REACH=L= 2400 FT

INFLOW INTO REACH=QP1= 6886 CFS
DEPTH OF FLOW=H1= 11.8 FT.
CROSS SECTIONAL AREA=A1= 2928 SQ.FT.
STORAGE IN REACH=V1= 161.3 AC. FT.

TRIAL REACH OUTFLOW=QP(TRIAL)= 4109 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 9.9 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 2029 SQ.FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 111.8 AC. FT.

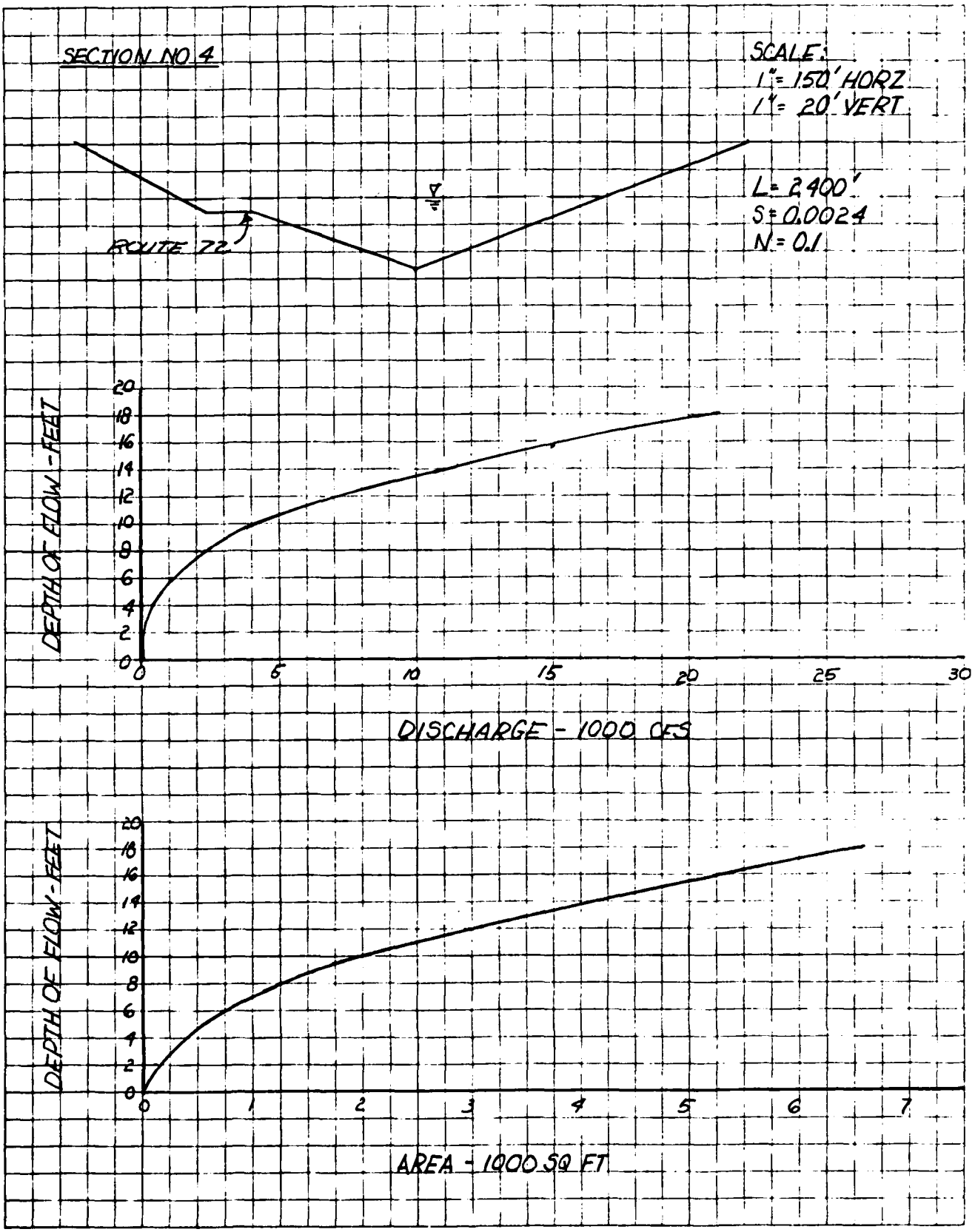
REACH OUTFLOW=QP2= 4535 CFS
DEPTH OF FLOW=H2= 10.3 FT.

BY PAM DATE 5-20-81 **ROALD HAESTAD, INC.** SHEET NO 18 OF 34

CONSULTING ENGINEERS

CKD BY SAL DATE 5/25/81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 049-044

SUBJECT BRISTOL RESERVOIR NO 2 - FLOOD ROUTING



BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 19 OF 3

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 5

TOTAL SECTION

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
1.0	30	15	0.50	0.0100	0.93	14
2.0	60	60	1.00	0.0100	1.48	89
3.0	90	135	1.50	0.0100	1.94	262
4.0	120	240	1.99	0.0100	2.35	565
5.0	150	375	2.49	0.0100	2.73	1024
6.0	181	540	2.99	0.0100	3.08	1666
7.0	211	735	3.49	0.0100	3.42	2513
8.0	241	960	3.99	0.0100	3.74	3588
9.0	271	1215	4.49	0.0100	4.04	4912
10.0	301	1500	4.99	0.0100	4.34	6505
11.0	346	1823	5.27	0.0100	4.50	8199
12.0	391	2190	5.60	0.0100	4.69	10263
13.0	436	2603	5.97	0.0100	4.89	12723
14.0	481	3060	6.36	0.0100	5.10	15608
15.0	526	3563	6.77	0.0100	5.32	18944
16.0	571	4110	7.19	0.0100	5.54	22759

MANNING COEFFICIENT=N=0.1000
STORAGE AT TIME OF FAILURE=S= 400 AC. FT.
LENGTH OF REACH=L= 2000 FT

INFLOW INTO REACH=QP1= 4535 CFS
DEPTH OF FLOW=H1= 8.7 FT.
CROSS SECTIONAL AREA=A1= 1142 SQ.FT.
STORAGE IN REACH=V1= 52.5 AC. FT.

TRIAL REACH OUTFLOW=QP(TRIAL)= 3940 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 8.3 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 1028 SQ.FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 47.2 AC. FT.

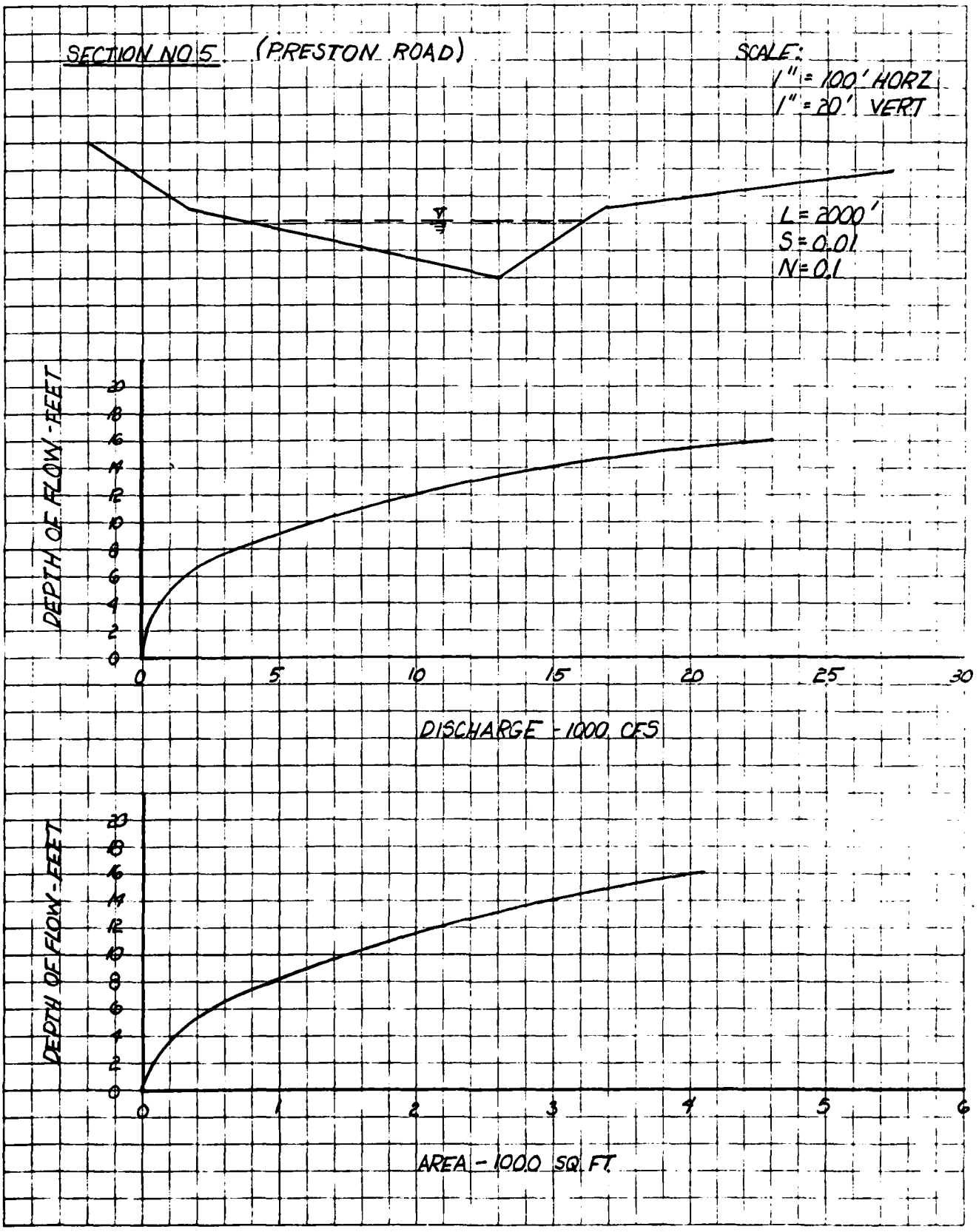
REACH OUTFLOW=QP2= 3970 CFS
DEPTH OF FLOW=H2= 8.3 FT.

BY PAM DATE 5-20-81 **ROALD HAESTAD, INC.** SHEET NO. 20 OF 5

CONSULTING ENGINEERS

CKD BY SAL DATE 5/25/81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO. 049-044

SUBJECT BRISTOL RESERVOIR NO. 2 - FLOOD ROUTING



BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 21 OF 56

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 6

TOTAL SECTION

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
1.0	28	14	0.50	0.0087	1.24	17
2.0	55	55	1.00	0.0087	1.98	109
3.0	83	124	1.50	0.0087	2.59	320
4.0	110	220	1.99	0.0087	3.14	690
5.0	138	344	2.49	0.0087	3.64	1251
6.0	165	495	2.99	0.0087	4.11	2035
7.0	193	674	3.49	0.0087	4.56	3069
8.0	221	880	3.99	0.0087	4.98	4382
9.0	248	1114	4.49	0.0087	5.39	6000
10.0	276	1375	4.99	0.0087	5.78	7946
11.0	289	1656	5.74	0.0087	6.35	10514
12.0	301	1950	6.47	0.0087	6.88	13410
13.0	314	2256	7.19	0.0087	7.37	16635
14.0	327	2575	7.88	0.0087	7.84	20191
15.0	339	2906	8.56	0.0087	8.29	24081

MANNING COEFFICIENT=N=0.0700
STORAGE AT TIME OF FAILURE=S= 400 AC. FT.
LENGTH OF REACH=L= 3000 FT

INFLOW INTO REACH=QP1= 3970 CFS
DEPTH OF FLOW=H1= 7.7 FT.
CROSS SECTIONAL AREA=A1= 815 SQ.FT.
STORAGE IN REACH=V1= 56.1 AC. FT.

TRIAL REACH OUTFLOW=QP(TRIAL)= 3413 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 7.3 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 728 SQ.FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 50.1 AC. FT.

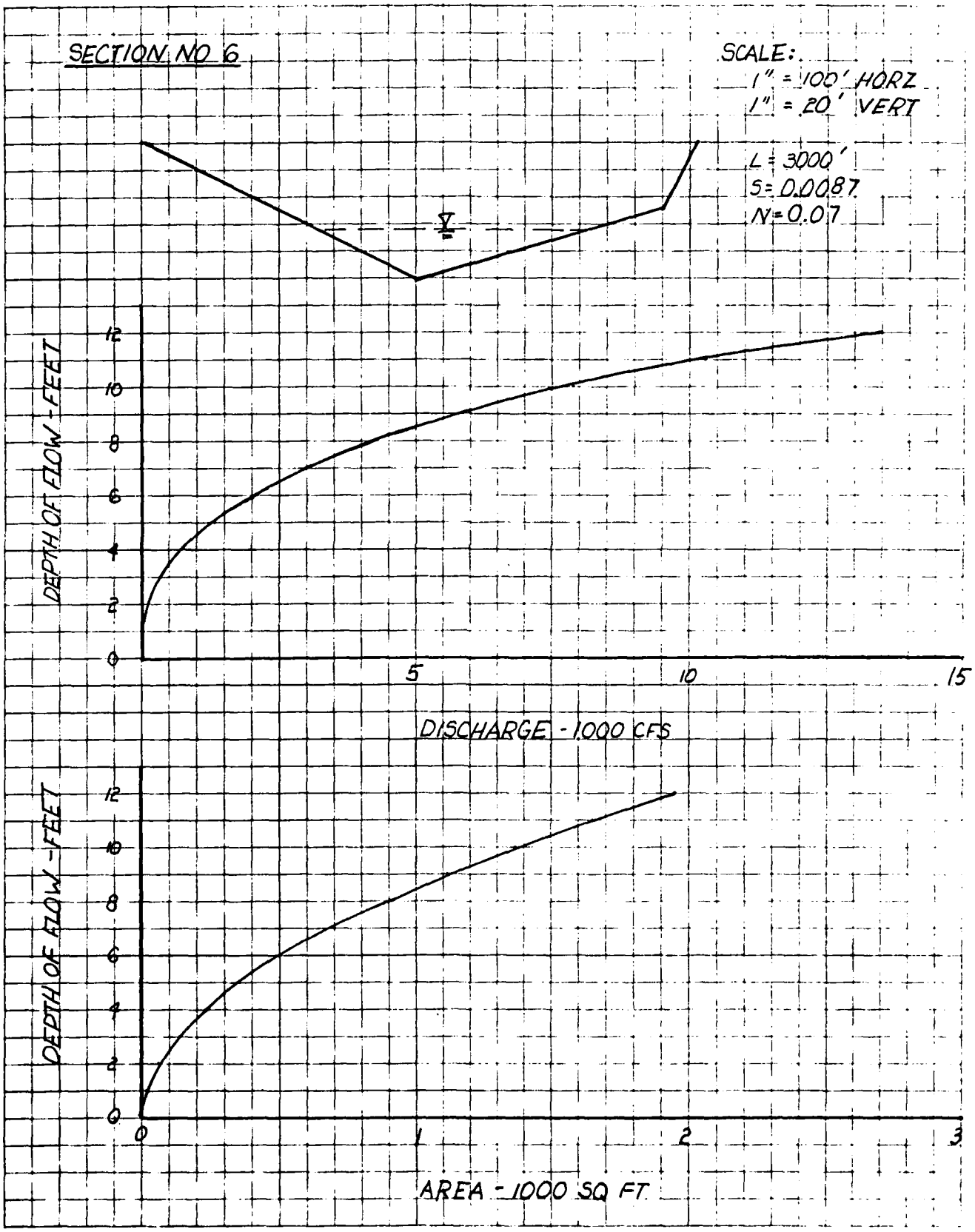
REACH OUTFLOW=QP2= 3443 CFS
DEPTH OF FLOW=H2= 7.3 FT.

BY PAM DATE 5-20-81 **ROALD HAESTAD, INC.** SHEET NO 25 OF ...

CONSULTING ENGINEERS

CKD BY SAL DATE 5/25/81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 049-044

SUBJECT BRISTOL RESERVOIR NO 2 - FLOOD ROUTING



BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 23 OF 33

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 7A

MAIN CHANNEL

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
1.0	18	9	0.50	0.0059	1.43	13
2.0	35	35	0.99	0.0059	2.27	80
3.0	53	79	1.49	0.0059	2.98	235
4.0	70	140	1.99	0.0059	3.61	505
5.0	88	219	2.48	0.0059	4.19	916
6.0	106	315	2.98	0.0059	4.73	1489
7.0	123	429	3.48	0.0059	5.24	2246
8.0	141	560	3.97	0.0059	5.73	3207
9.0	159	709	4.47	0.0059	6.19	4391
10.0	176	875	4.97	0.0059	6.65	5815
11.0	179	1051	5.88	0.0059	7.43	7816
12.0	182	1230	6.78	0.0059	8.17	10054
13.0	184	1411	7.66	0.0059	8.87	12519
14.0	187	1595	8.53	0.0059	9.53	15204
15.0	190	1781	9.39	0.0059	10.16	18103
16.0	192	1970	10.24	0.0059	10.77	21212
17.0	195	2161	11.08	0.0059	11.35	24526
18.0	198	2355	11.91	0.0059	11.91	28041
19.0	200	2551	12.73	0.0059	12.45	31755
20.0	203	2750	13.54	0.0059	12.97	35666

MANNING COEFFICIENT=N=0.0500

BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 24 OF 36

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 7B

RIGHT OVERBANK

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
11.0	52	49	0.93	0.0059	2.17	105
12.0	55	102	1.85	0.0059	3.44	351
13.0	58	158	2.73	0.0059	4.46	705
14.0	61	217	3.58	0.0059	5.34	1157
15.0	63	278	4.39	0.0059	6.12	1700
16.0	66	341	5.17	0.0059	6.83	2331
17.0	69	408	5.93	0.0059	7.48	3049
18.0	71	476	6.67	0.0059	8.09	3851
19.0	74	548	7.38	0.0059	8.65	4739
20.0	77	621	8.08	0.0059	9.19	5711

MANNING COEFFICIENT=N=0.0500

BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 25 OF 3

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 7

TOTAL SECTION

	AREA (SQ.FT.)			DISCHARGE (CFS)		
H	A	B	TOTAL	A	B	TOTAL
1.0	9	0	9	13	0	13
2.0	35	0	35	80	0	80
3.0	79	0	79	235	0	235
4.0	140	0	140	505	0	505
5.0	219	0	219	916	0	916
6.0	315	0	315	1489	0	1489
7.0	429	0	429	2246	0	2246
8.0	560	0	560	3207	0	3207
9.0	709	0	709	4391	0	4391
10.0	875	0	875	5815	0	5815
11.0	1051	49	1100	7816	105	7921
12.0	1230	102	1332	10054	351	10405
13.0	1411	158	1569	12519	705	13224
14.0	1595	217	1812	15204	1157	16361
15.0	1781	278	2059	18103	1700	19803
16.0	1970	341	2311	21212	2331	23543
17.0	2161	408	2569	24526	3049	27574
18.0	2355	476	2831	28041	3851	31893
19.0	2551	548	3099	31755	4739	36494
20.0	2750	621	3371	35666	5711	41377

STORAGE AT TIME OF FAILURE=S= 400 AC. FT.
LENGTH OF REACH=L= 1300 FT

INFLOW INTO REACH=QP1= 3443 CFS
DEPTH OF FLOW=H1= 8.2 FT.
CROSS SECTIONAL AREA=A1= 590 SQ.FT.
STORAGE IN REACH=V1= 17.6 AC. FT.

TRIAL REACH OUTFLOW=QP(TRIAL)= 3291 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 8.1 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 571 SQ.FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 17.0 AC. FT.

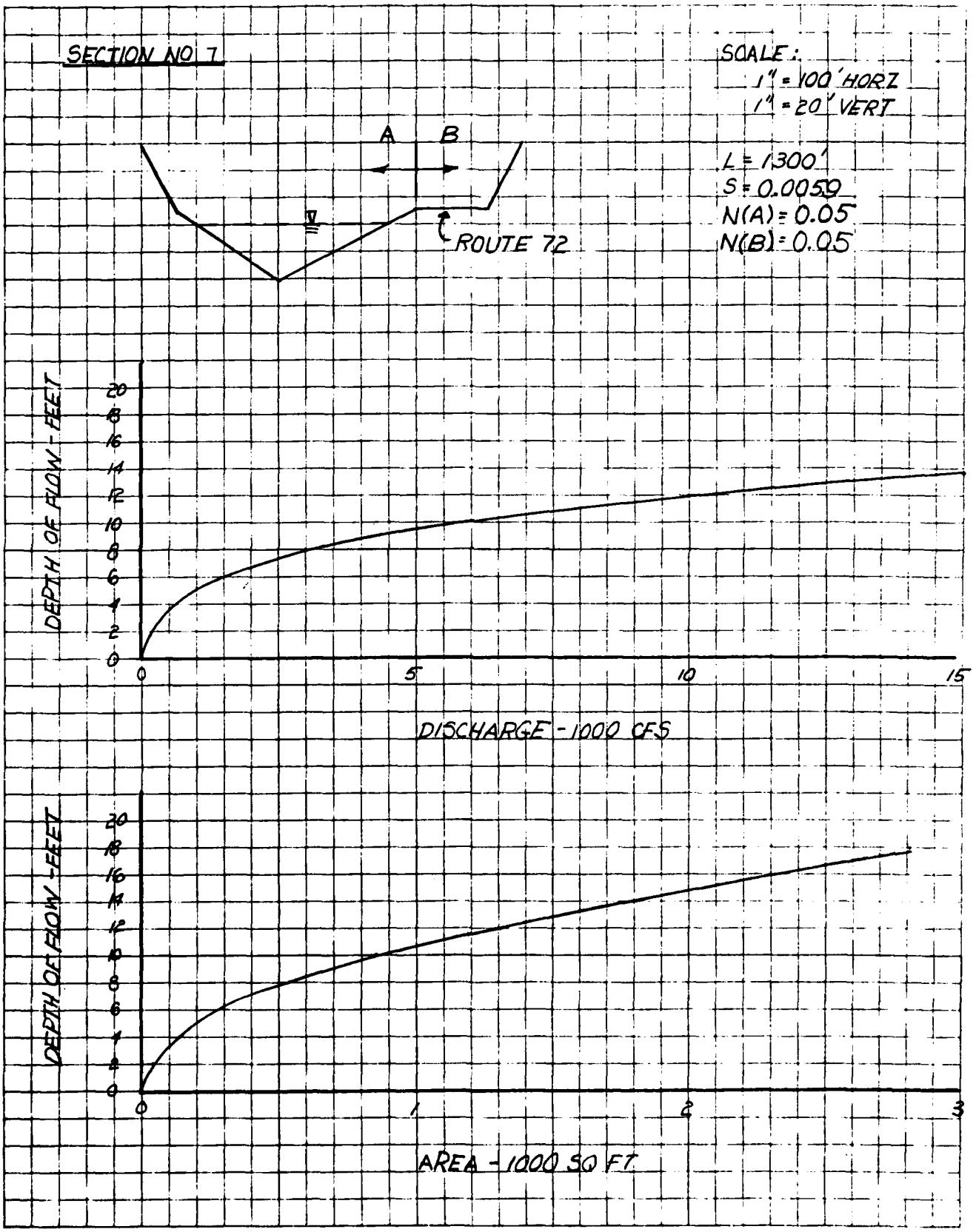
REACH OUTFLOW=QP2= 3294 CFS
DEPTH OF FLOW=H2= 8.1 FT.

BY PAM DATE 5-20-81 **ROALD HAESTAD, INC.** SHEET NO 26 OF 36

CONSULTING ENGINEERS

CKD BY SAL DATE 5-26-81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 049-044

SUBJECT BRISTOL RESERVOIR NO. 2 - FLOOD ROUTING



BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 27 OF 3

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 8

TOTAL SECTION

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
1.0	613	552	0.90	0.0044	1.53	845
2.0	682	1199	1.76	0.0044	2.39	2871
3.0	750	1915	2.55	0.0044	3.07	5877
4.0	769	2674	3.48	0.0044	3.77	10088
5.0	787	3452	4.39	0.0044	4.40	15193

MANNING COEFFICIENT=N=0.0600
STORAGE AT TIME OF FAILURE=S= 400 AC. FT.
LENGTH OF REACH=L= 3000 FT

INFLOW INTO REACH=QP1= 3294 CFS
DEPTH OF FLOW=H1= 2.1 FT.
CROSS SECTIONAL AREA=A1= 1300 SQ.FT.
STORAGE IN REACH=V1= 89.5 AC. FT.

TRIAL REACH OUTFLOW=QP(TRIAL)= 2557 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 1.8 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 1099 SQ.FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 75.7 AC. FT.

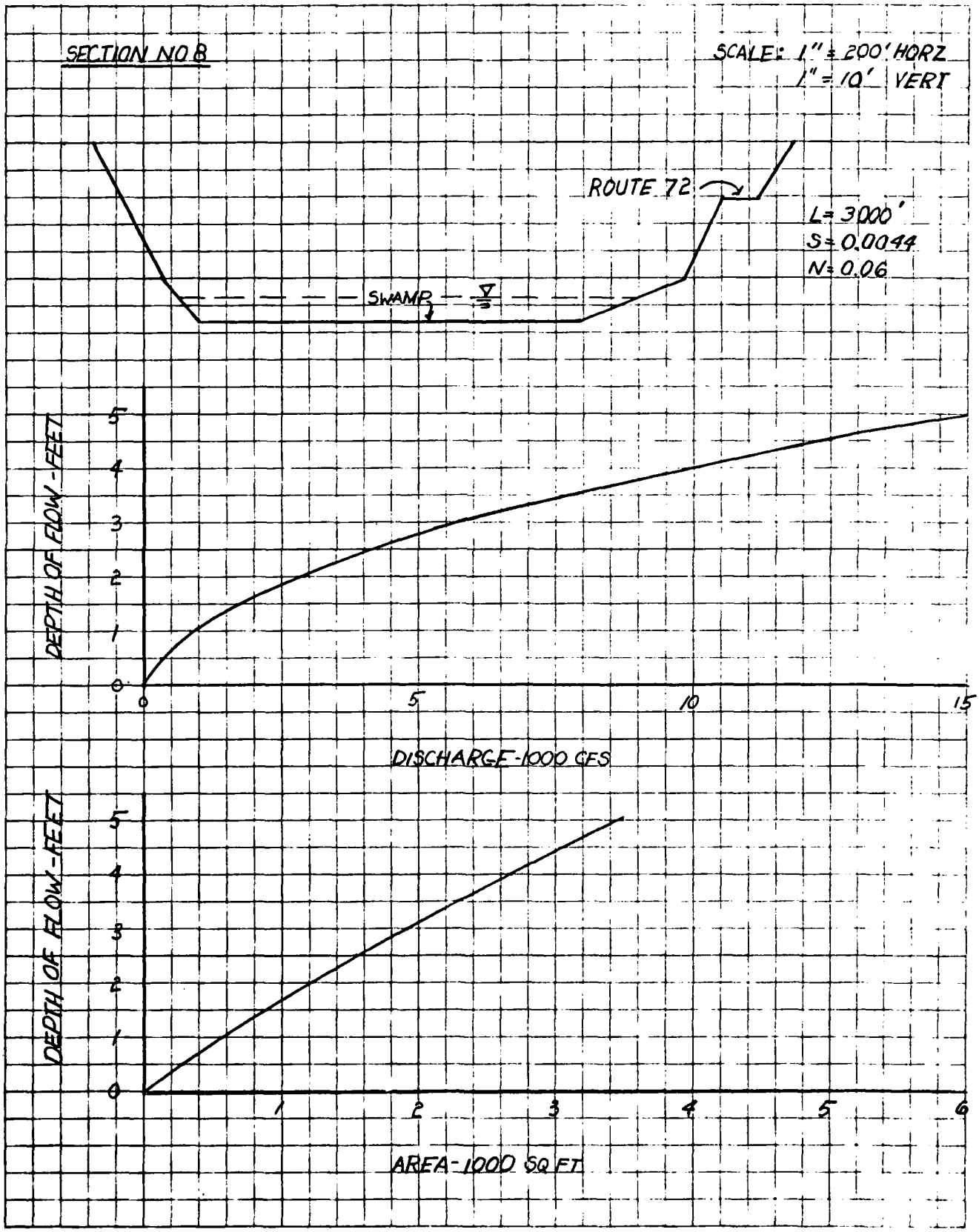
REACH OUTFLOW=QP2= 2614 CFS
DEPTH OF FLOW=H2= 1.9 FT.

BY PAM DATE 5-20-81 **ROALD HAESTAD, INC.** SHEET NO 48 OF 56

CONSULTING ENGINEERS

CKD BY SAL DATE 5/25/81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 049-044

SUBJECT BRISTOL RESERVOIR NO 2 - FLOOD ROUTING



BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 29 OF 56

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 9A

MAIN CHANNEL

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
1.0	158	146	0.93	0.0050	1.25	182
2.0	166	307	1.85	0.0050	1.98	609
3.0	174	476	2.74	0.0050	2.57	1226
4.0	182	653	3.59	0.0050	3.08	2013
5.0	190	838	4.41	0.0050	3.53	2962
6.0	198	1031	5.21	0.0050	3.95	4066
7.0	202	1229	6.09	0.0050	4.38	5384
8.0	209	1433	6.85	0.0050	4.74	6784
9.0	217	1644	7.58	0.0050	5.07	8333
10.0	224	1863	8.30	0.0050	5.39	10030

MANNING COEFFICIENT=N=0.0800

BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 30 OF 36

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 9B

RIGHT OVERBANK

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
7.0	54	49	0.91	0.0050	1.23	61
8.0	59	106	1.80	0.0050	1.94	205
9.0	64	167	2.62	0.0050	2.50	417
10.0	68	232	3.40	0.0050	2.97	690

MANNING COEFFICIENT=N=0.0800

BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 31 OF 36

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 9

TOTAL SECTION

	AREA (SQ.FT.)			DISCHARGE (CFS)		
H	A	B	TOTAL	A	B	TOTAL
1.0	146	0	146	182	0	182
2.0	307	0	307	609	0	609
3.0	476	0	476	1226	0	1226
4.0	653	0	653	2013	0	2013
5.0	838	0	838	2962	0	2962
6.0	1031	0	1031	4066	0	4066
7.0	1229	49	1278	5384	61	5445
8.0	1433	106	1538	6784	205	6990
9.0	1644	167	1811	8333	417	8749
10.0	1863	232	2095	10030	690	10720

STORAGE AT TIME OF FAILURE=S= 400 AC. FT.
LENGTH OF REACH=L= 2000 FT

INFLOW INTO REACH=QP1= 2614 CFS
DEPTH OF FLOW=H1= 4.6 FT.
CROSS SECTIONAL AREA=A1= 770 SQ.FT.
STORAGE IN REACH=V1= 35.4 AC. FT.

TRIAL REACH OUTFLOW=QP(TRIAL)= 2383 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 4.4 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 725 SQ.FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 33.3 AC. FT.

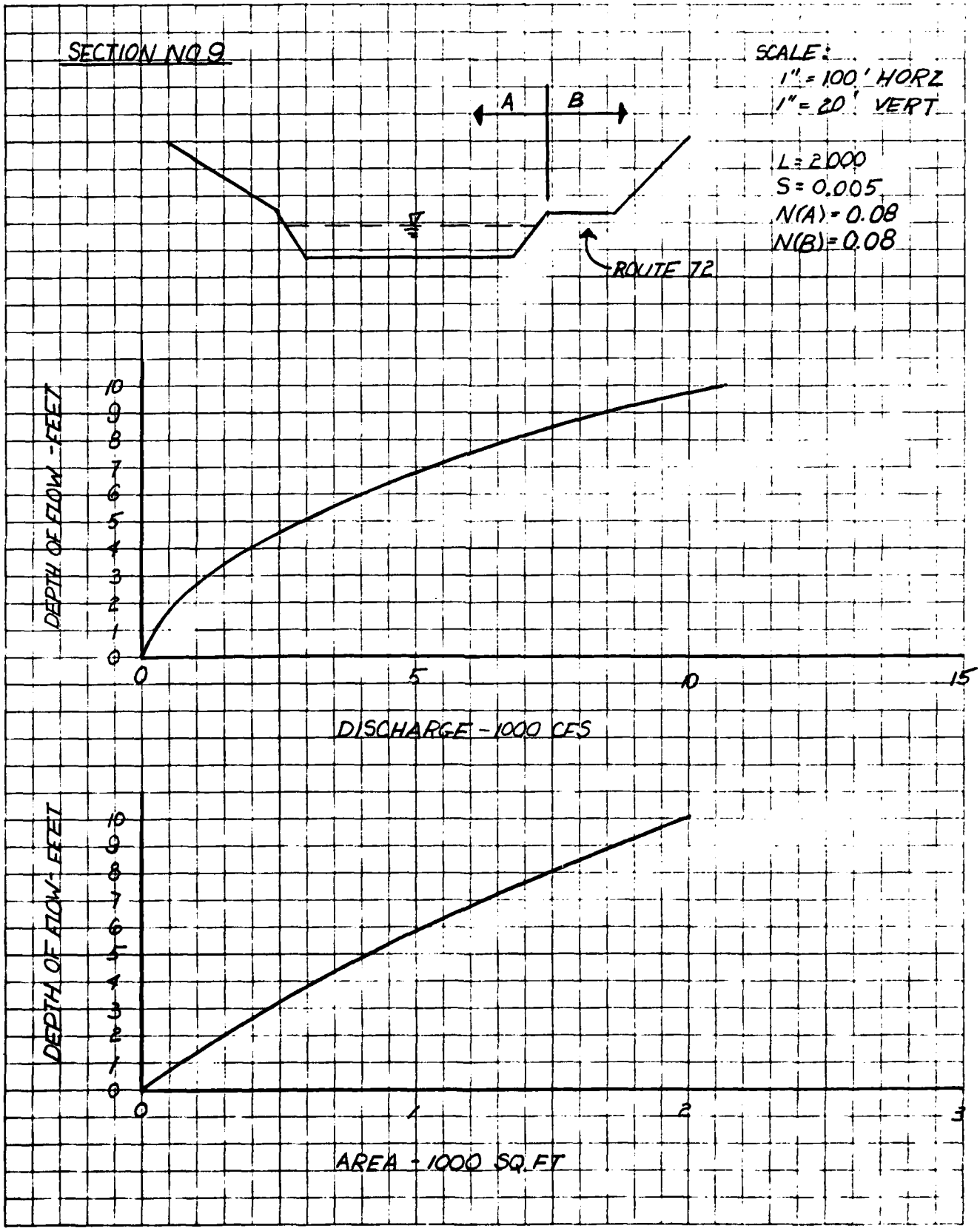
REACH OUTFLOW=QP2= 2389 CFS
DEPTH OF FLOW=H2= 4.4 FT.

BY PAM DATE 5-20-81 **ROALD HAESTAD, INC.** SHEET NO 21 OF 36

CONSULTING ENGINEERS

CKD BY SAL DATE 5/25/81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 049-044

SUBJECT BRISTOL RESERVOIR NO. 2 - FLOOD ROUTING



BY SAL DATE 5/25/81 ROALD HAESTAD, INC. SHEET NO 33 OF 3[illegible]

CKD BY DLS DATE 5/26/81 CONSULTING ENGINEERS JOB NO. 049 044

SUBJECT BRISTOL RESERVOIR NO. 2-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 10

TOTAL SECTION

H (FT)	W (FT)	A (SQ-FT)	R (FT)	S (FT/FT)	V (FT/SEC)	Q (CFS)
1.0	20	10	0.50	0.0160	2.95	30
2.0	40	40	1.00	0.0160	4.68	187
3.0	60	90	1.49	0.0160	6.14	552
4.0	80	160	1.99	0.0160	7.43	1190
5.0	100	250	2.49	0.0160	8.63	2157
6.0	121	360	2.99	0.0160	9.74	3507
7.0	141	490	3.48	0.0160	10.80	5290
8.0	161	640	3.98	0.0160	11.80	7553
9.0	181	810	4.48	0.0160	12.77	10340
10.0	201	1000	4.98	0.0160	13.69	13695

MANNING COEFFICIENT=N=0.0400
STORAGE AT TIME OF FAILURE=S= 400 AC. FT.
LENGTH OF REACH=L= 1250 FT

INFLOW INTO REACH=QP1= 2389 CFS
DEPTH OF FLOW=H1= 5.2 FT.
CROSS SECTIONAL AREA=A1= 269 SQ.FT.
STORAGE IN REACH=V1= 7.7 AC. FT.

TRIAL REACH OUTFLOW=QP(TRIAL)= 2343 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 5.1 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 265 SQ.FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 7.6 AC. FT.

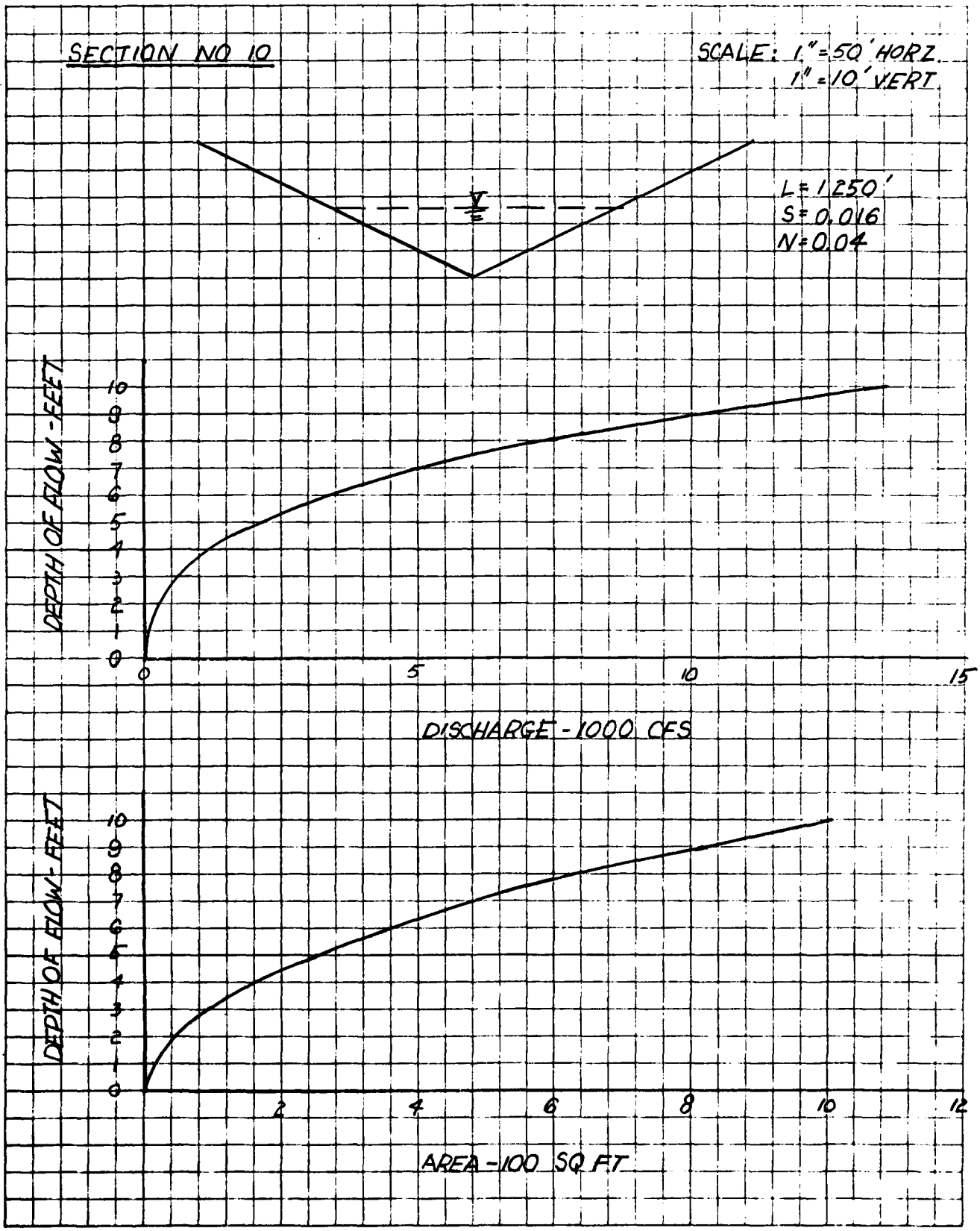
REACH OUTFLOW=QP2= 2344 CFS
DEPTH OF FLOW=H2= 5.1 FT.

BY PAM DATE 5-20-81 **ROALD HAESTAD, INC.** SHEET NO. 34 OF 36

CONSULTING ENGINEERS

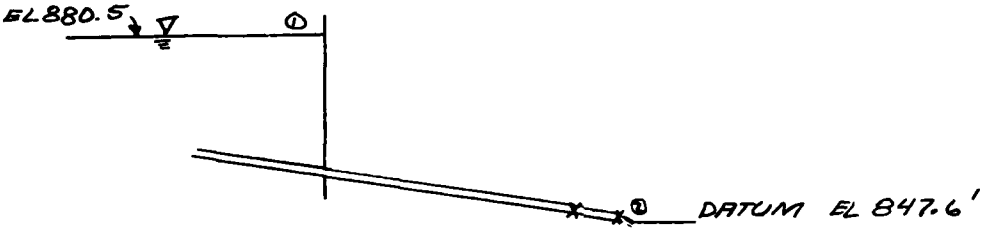
CKD BY SAL DATE 5/25/81 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 049-044

SUBJECT BRISTOL RESERVOIR NO. 2 - FLOOD ROUTING



Data: 1) 12" Cast Iron pipe approximately 140' long.
2) 2-gate valves downstream
3) Top of dam EL. 880.5, Inv. EL. 847.6'.

Head Losses: 1) Friction → $f\,L/D\,V_2^2/2g$
2) Entrance - projecting $K\,V_2^2/2g$ $\{K = 1.0\}$
3) Gate Valves - $K\,V_2^2/2g$ $\{K = 0.25\}$



Use Bernoulli Equation.

$$z_1 + p_1/\gamma + V_1^2/2g = z_2 + p_2/\gamma + V_2^2/2g + H_{L\,1-2}$$

$$32.9' + 0 + 0 = 0 + 0 + V_2^2/2g + \left[140f + 1 + 2(0.25)\right] V_2^2/2g$$

$$32.9 = (140f + 2.5)\, V_2^2/2g$$

Solve by Trial & Error;

V_2 Assumed $= 20$ ft/sec $\rightarrow f = 0.0360 \rightarrow \therefore V_2 = 16.8$ ft/sec
" " $= 17$ ft/sec $\rightarrow f = 0.0363 \rightarrow \therefore V_2 = 16.7$ ft/sec

$$Q_{(TOP\ OF\ DAM)} = V_2 A$$
$$= 16.7\ \text{ft/sec}\left(\pi(1)^2/4\right)$$
$$= 13\ \text{cfs}$$

BY J.B. DATE 5-18-81

CKD BY SAL DATE 5/27/81

ROALD HAESTAD, INC.
CONSULTING ENGINEERS
37 Brookside Road - Waterbury, Conn. 06708

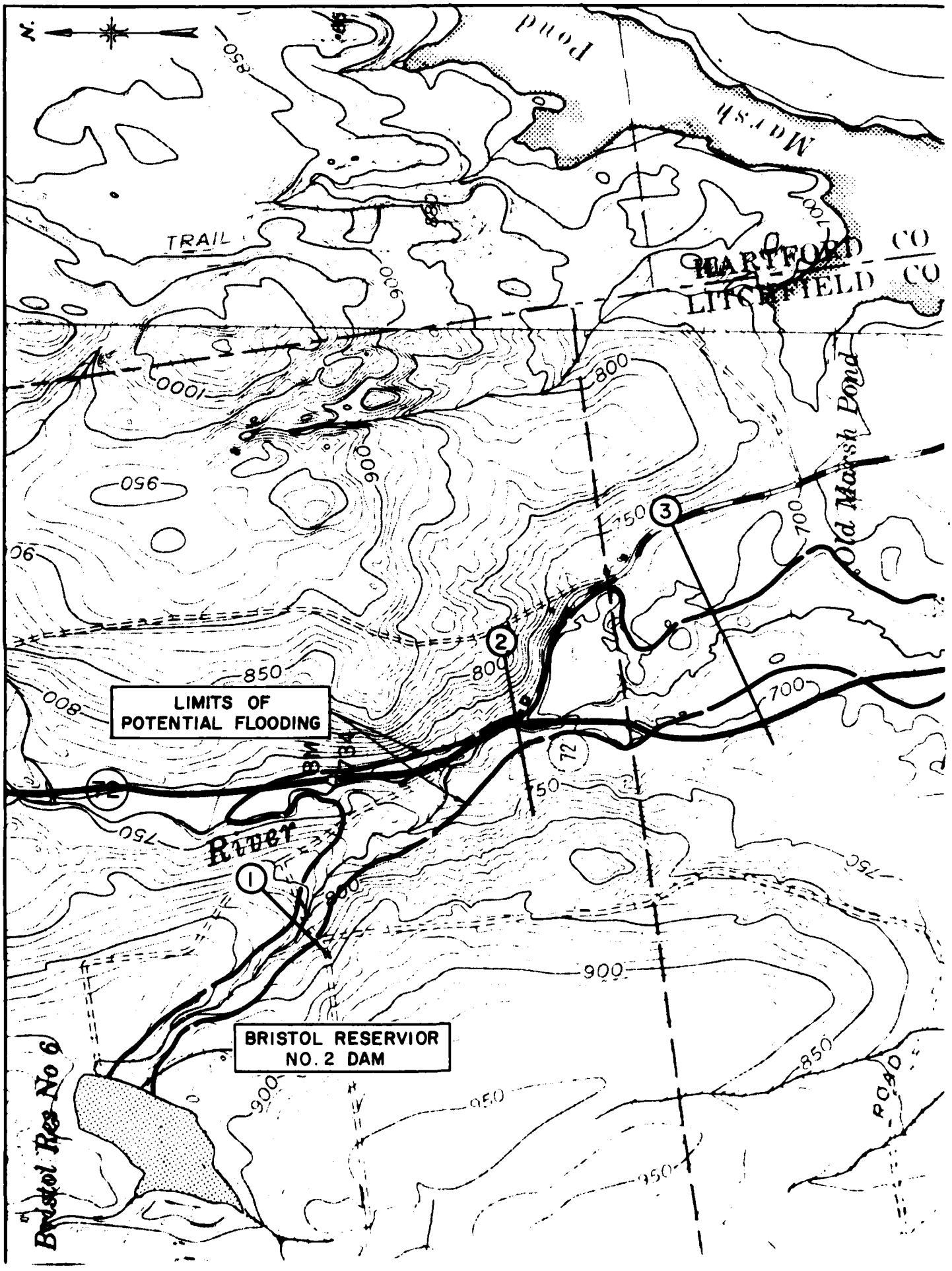
SHEET NO. 5a OF 5

JOB NO 49-044

SUBJECT BRISTOL RESERVOIR No. 2 - SURFACE AREA

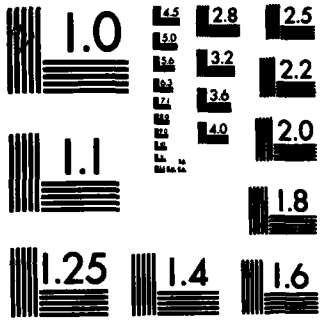
PLANIMETER READINGS:
(SCALE: 1" = 2000')

WATER SURFACE (EL. 877)	THIRD	48.81	SQ. IN.	0.19	17.5 ACRES
	FIRST	48.44	SQ IN	0.19	
	START	48.25	SQ IN.		
WATERSHED	THIRD	55.29	SQ. IN.	2.17	199 ACRES
	FIRST	50.95	SQ. IN.	2.16	= 0.31 SQ. MI.
	START	48.79	SQ. IN.		
CONTOUR 880	THIRD	12.10	SQ. IN.	0.22	20.2 ACRES
	FIRST	11.67	SQ. IN.	0.23	
	START	11.44	SQ. IN.		
CONTOUR 890	THIRD	16.61	SQ. IN.	0.30	27.5 ACRES
	FIRST	16.01	SQ IN.	0.30	
	START	15.71	SQ IN.		


N
Pond
TRAIL
HARTFORD CO
LITCHFIELD CO
Old Marsh Pond
LIMITS OF
POTENTIAL FLOODING
River
BRISTOL RESERVIOR
NO. 2 DAM
Bristol Res No 6
1
2
3
72
850
800
750
700
900
950
1000

AD-A143 938 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
BRISTOL RESERVOIR NUM.. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV JUN 81

UNCLASSIFIED F/G 13/13 NL



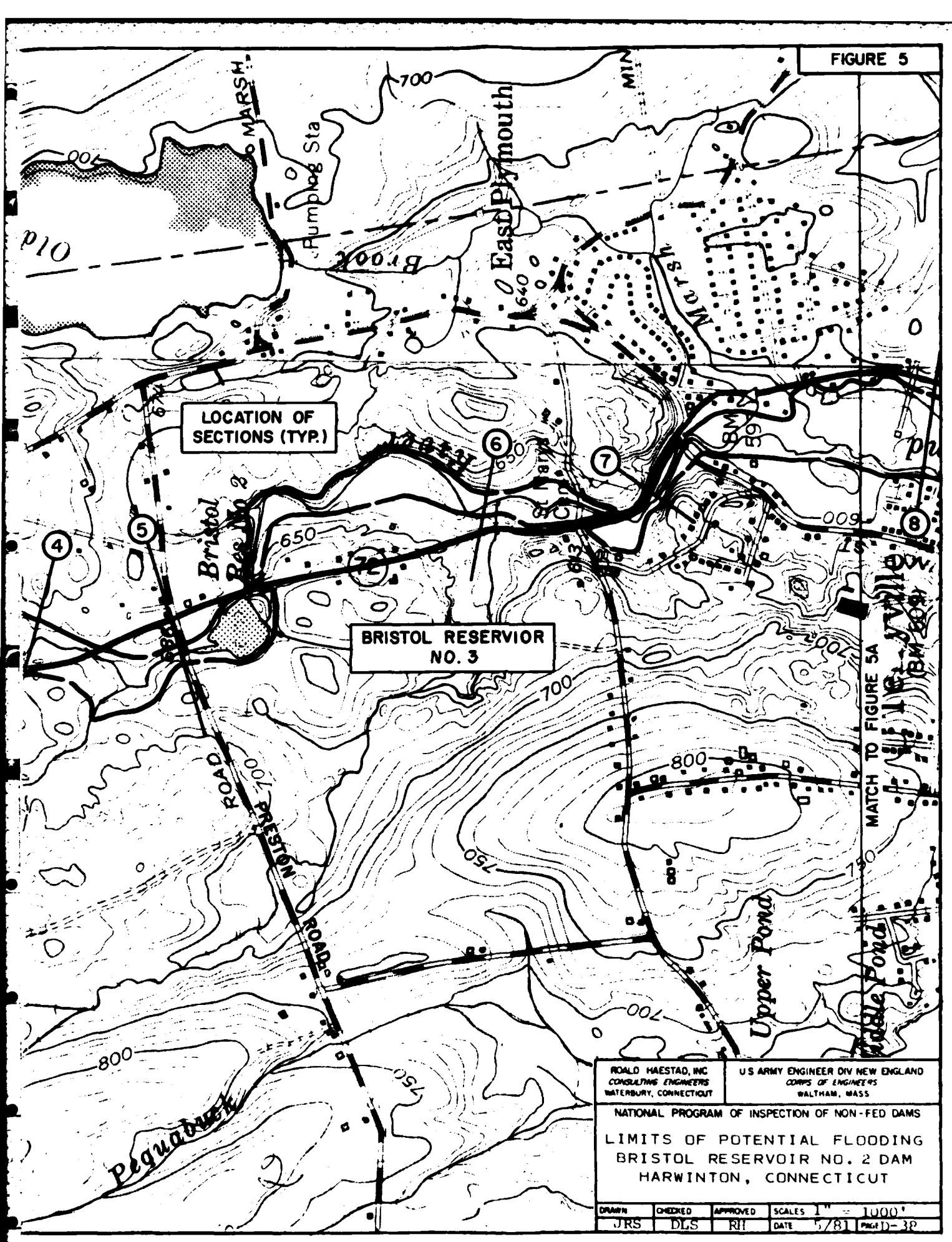
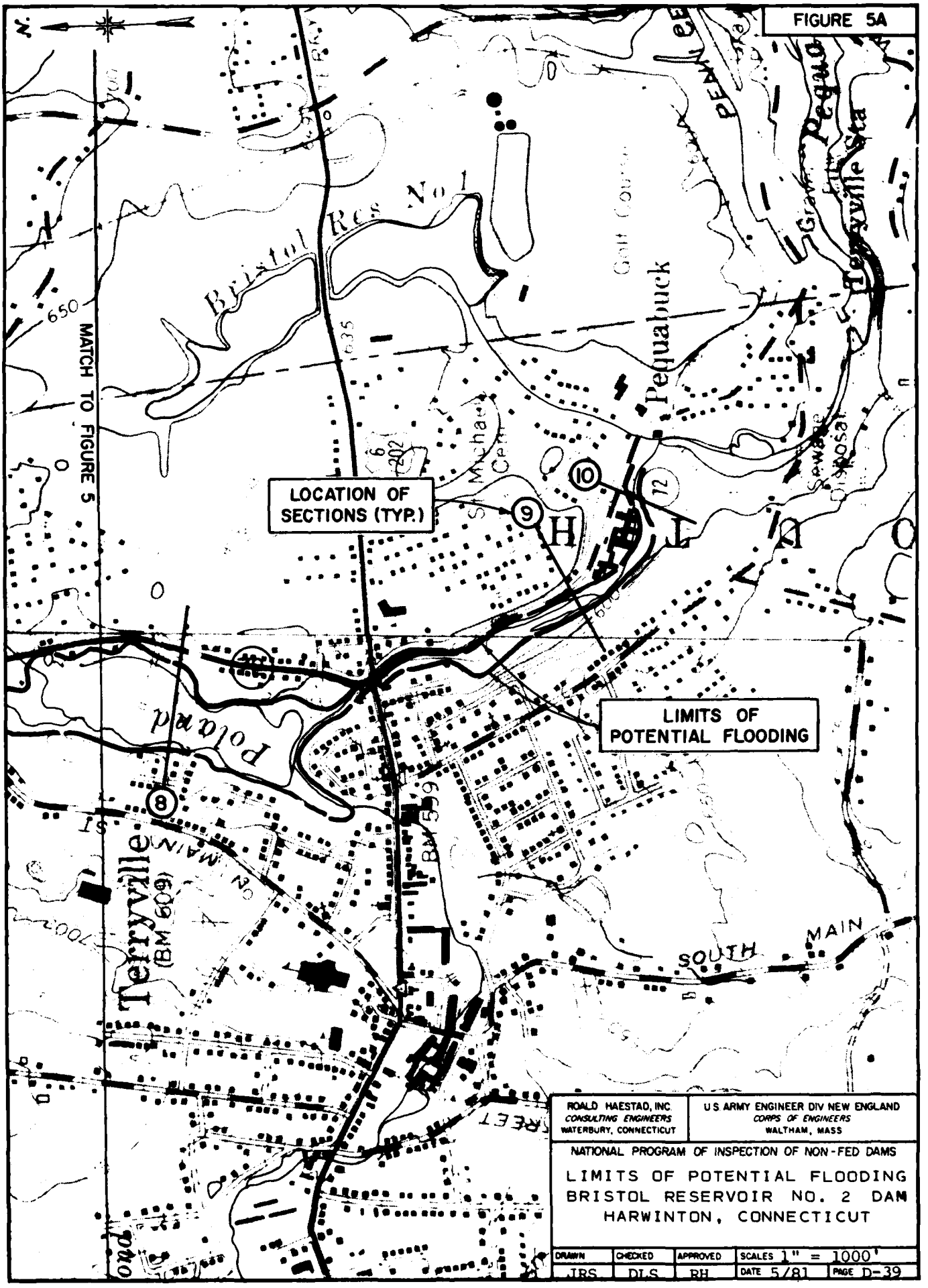


FIGURE 5
LOCATION OF SECTIONS (TYP.)
BRISTOL RESERVIOR NO. 3
Bristol Res No 2
East Plymouth
Pumping Sta
MARSH
Brook
MARSH
MATCH TO FIGURE 5A
ROAD
PRESTON
ROAD
Upper Pond
Eddie Pond
Pequabuck
700
800
650
640
630
750
ROALD HAESTAD, INC
CONSULTING ENGINEERS
WATERBURY, CONNECTICUT
U S ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
LIMITS OF POTENTIAL FLOODING
BRISTOL RESERVOIR NO. 2 DAM
HARWINTON, CONNECTICUT
DRAWN JRS
CHECKED DLS
APPROVED RH
SCALES 1" = 1000'
DATE 5/81
PAGE D-38

FIGURE 5A



ROALD HAESTAD, INC.
CONSULTING ENGINEERS
WATERBURY, CONNECTICUT

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LIMITS OF POTENTIAL FLOODING
BRISTOL RESERVOIR NO. 2 DAM
HARWINTON, CONNECTICUT

DRAWN	CHECKED	APPROVED	SCALES 1" = 1000'
JRS	DLS	RH	DATE 5/81

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

END

FILMED

9-84

DTIC